Product Engineering

THE McGRAW-HILL MAGAZINE OF DESIGN ENGINEERING

FIVE DOLLARS A YEAR

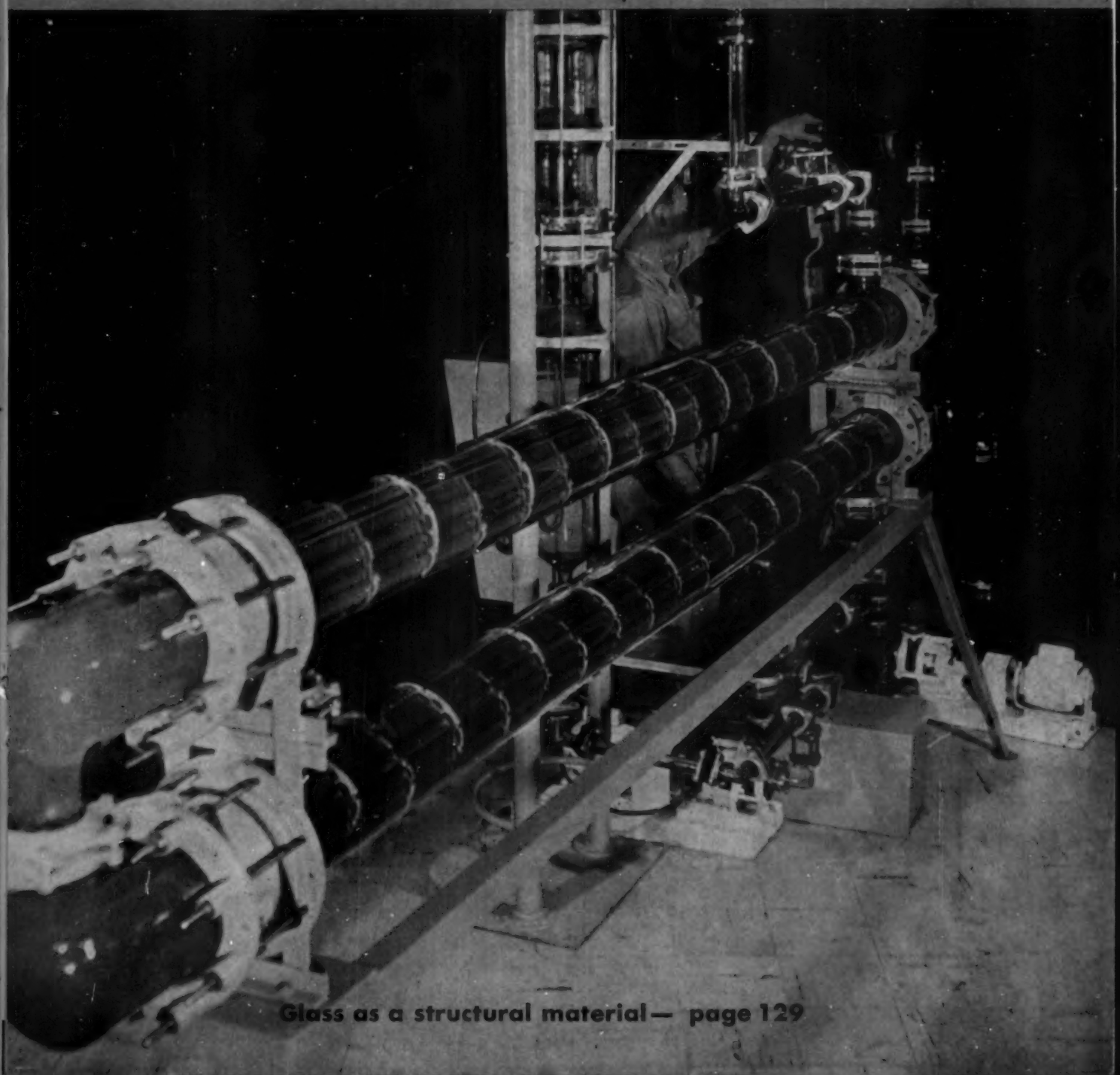
JUNE 1955

Simplifying Design of
TORSION SPRINGS

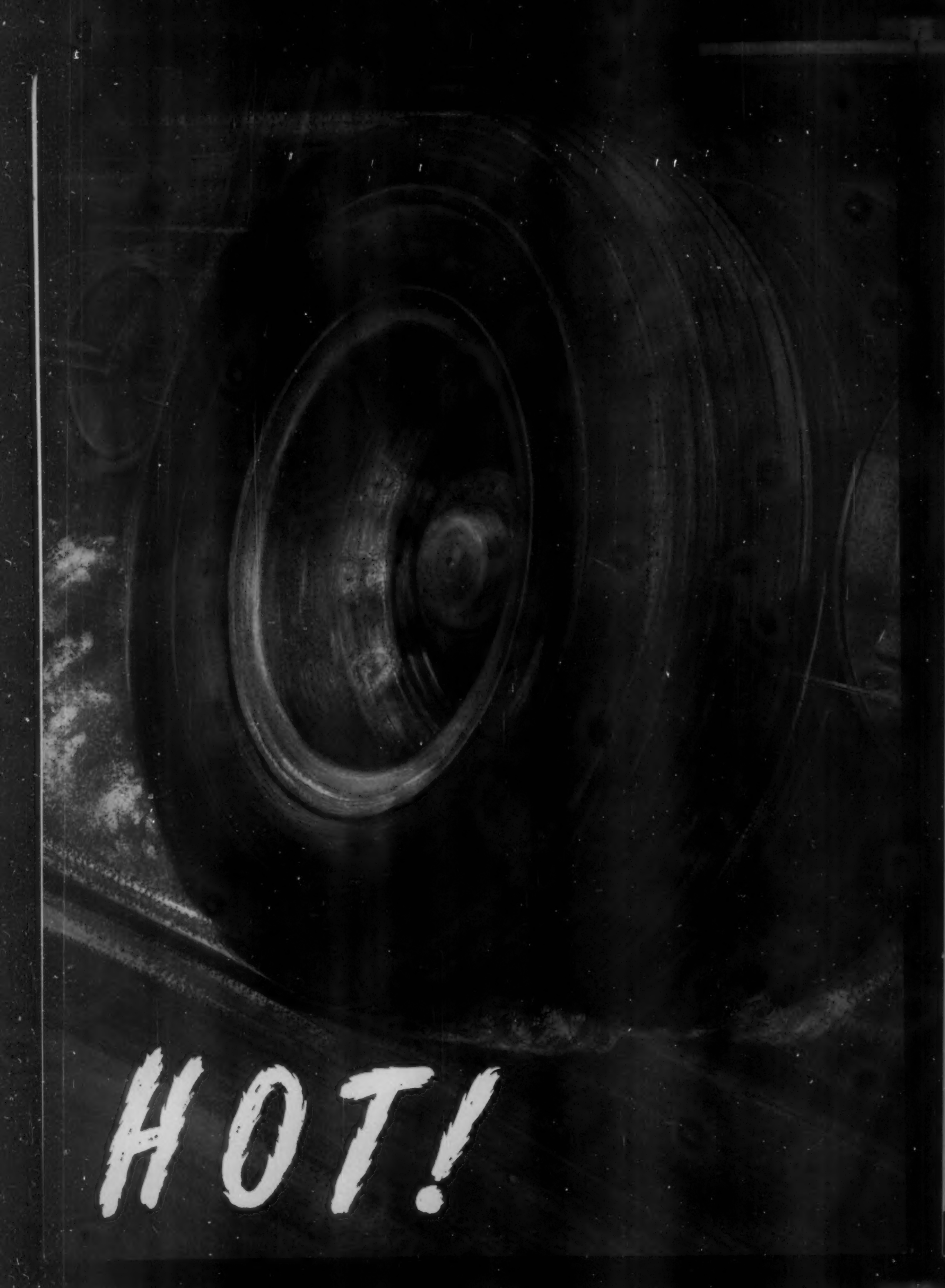
Punched Card Control

Shock Isolation

Directional Valves



Glass as a structural material— page 129


HOT!

Braking big wheels won't burn

SIRVENE H-T Oil Seals

Now generally available, C/R's new sealing material resists temperatures up to 350° F.

Why the heat's on—Bigger engines, higher speeds, faster deceleration . . . these factors have pushed up temperatures in brake drums, axles, pinions and transmissions. Burn-out of oil seals has become a costly problem. With miles per year jumping to 120,000 and more, maintenance men know that standard oil seals can't take the heat, won't go the distance required on today's high-mileage fleets.

C/R research solves it—Sirvene HT Oil Seals are available in a series of high temperature synthetic rubber compounds developed from special polymers for exceptionally hot applications. They seal effectively at temperatures up to 350° F. With a longer service life than any previously known heat-resistant sealing material, Sirvene HT Oil Seals mean big savings for operators of trucks, buses, tractors, road machinery, automobiles and aircraft.

Five years of proved performance—Five years ago, exhaustive testing in C/R Research and Engineering Laboratories indicated the exceptionally high heat resistance and long service potential of Sirvene HT Oil Seals. Since then the dependability of these seals has been consistently demonstrated in aircraft, truck, road machinery and related applications.

Facts for engineers—Starting twenty years ago, Chicago Rawhide pioneered the development of high temperature sealing elements. First, Sirvis leather, then Sirvene (synthetic rubber) compounds which sealed effectively at 250° F. Now engineers may have the complete facts on this newest series of high temperature compounds.

Chicago Rawhide's unequalled oil seal development experience and facilities are also at your service. Please write.

C/R

PERFECT Oil Seals

More automobiles, farm equipment and industrial machines rely on C/R Oil Seals than on any similar sealing device.

CHICAGO RAWHIDE MANUFACTURING COMPANY

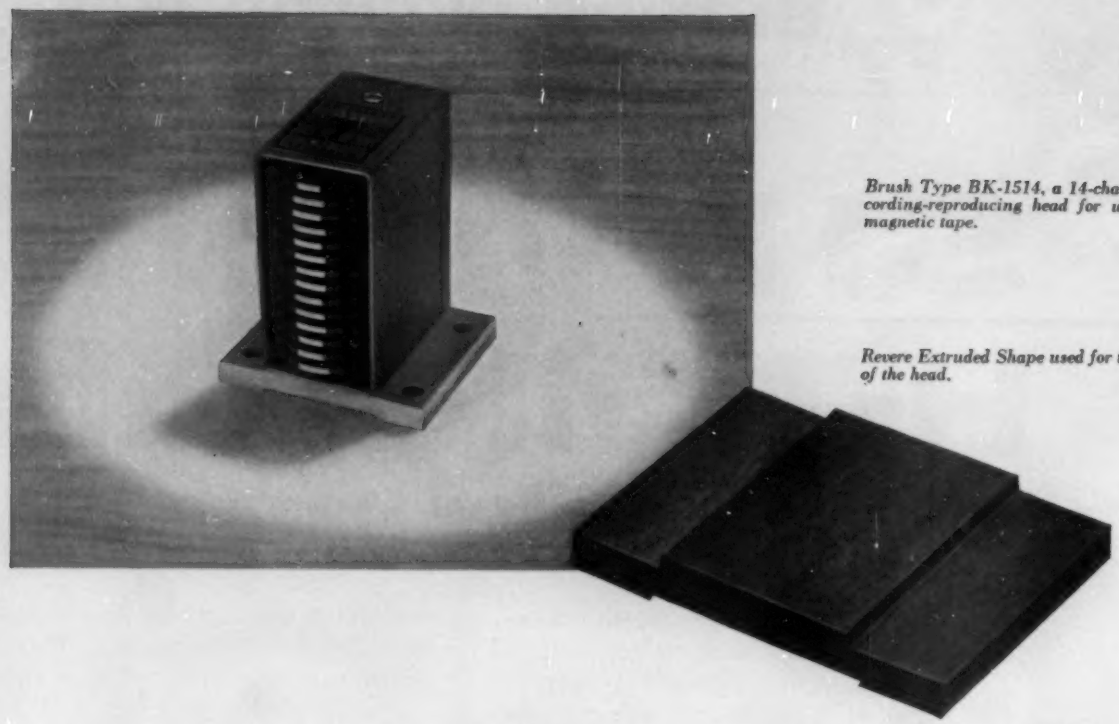
1301 Elston Avenue OIL SEAL DIVISION Chicago 22, Illinois

IN CANADA: MANUFACTURED AND DISTRIBUTED BY SUPER OIL SEAL MFG. CO., LTD., HAMILTON, ONTARIO

EXPORT SALES: GEON INTERNATIONAL CORP., GREAT NECK, NEW YORK

Other **C/R** *products*

SIRVENE: (Synthetic rubber) diaphragms, boots, gaskets and similar parts for critical operating conditions • CONFOR: Controlled porosity mechanical leather packings and other sealing products • SIRVIS: Mechanical leather boots, gaskets, packings and related products.



Brush Type BK-1514, a 14-channel recording-reproducing head for use with magnetic tape.

Revere Extruded Shape used for the base of the head.

Revere Extruded Shape

Saves 15¢ per piece

For Brush

The base of the magnetic recording-reproducing head shown here is a Revere brass extruded shape. You can see that it is rather simple in design, yet Brush Electronics Co., Cleveland, Ohio, reports that the shape saves 15¢ per piece (1½" long) over the previous method of milling the piece out of solid bar. There were three operations required on the bar, which weighed 1.61 lb. per foot, against 1.22 lb. per foot for the shape. Eliminating the machining operations, and reducing scrap almost to the vanishing point, produced the economy.

The head in question can record and reproduce signals from 14 channels, at frequencies within, below, or above the audible range. Such a head is being increasingly employed to handle information to be used for computation, telemetering, inventory records, process control (automation) and similar purposes.

Extruded shapes by Revere should be looked into if you are doing any extensive machining of raw stock in copper and its alloys, and aluminum alloys. The extrusion process is much like squeezing paste from a tube. Much more intricate shapes than the one shown here are possible. Naturally, all design lines must be parallel to the axis of extrusion. Get in touch with the nearest Revere Sales Office, and see if Revere Extruded Shapes may not save you money.

REVERE

COPPER AND BRASS INCORPORATED

Founded by Paul Revere in 1801

230 Park Avenue, New York 17, N. Y.

• • •

Mills: Baltimore, Md.; Chicago and Clinton, Ill.; Detroit, Mich.; Los Angeles and Riverside, Calif.; New Bedford, Mass.; Rome, N. Y.— Sales Offices in Principal Cities, Distributors Everywhere.

Product Engineering

JUNE 1955 Vol. 26 No. 6 The McGraw-Hill Magazine of Design Engineering

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Corrosion resistance, elastic properties, thermal conductivity, dielectric strength and moldability tabulated for five types including the new 96 per cent silica composition.

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Step-by-step design procedure replaces trial and error method and simplifies calculation; includes practical evaluation of service life.

Product Designs 144
Gear grinder with automatic wheel dressing; Accounting machine prints 900 lines per min.; Resistance welder redesigned and restyled; Piston-type hand pump.

Motors for Portable Tools ..... J. H. Karr 156
Design procedure and data for determining optimum motor diameter and length for power and speed needed.

Clad Metals ..... Herbert Schwartz 162
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Punched Card Control for Automatic Machines ..... Alan H. Stillman 172
How card calculators and card-to-tape converters reduce time for computation and preparation of punched tape for machine control.

Cabinet Design for Complex Equipment ..... Robert H. Tanner 177
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Relay blade redesigned for reduction in both material and labor.

Differential Winch in Control Systems ..... Alexander B. Hulse, Jr. and Robert Aymar 184
Five methods for changing rotary to linear motion with mechanical magnification.

Directional Valves for Hydraulic Circuits ..... Walter Brown 186
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Nine ideas for long term as well as immediate saving, without overdoing "simplification".

Bearing Loads on Geared Shafts ..... Zbigniew Jania 209
Simple, fast and accurate graphical method of calculating both direction and magnitude of bearing loads.

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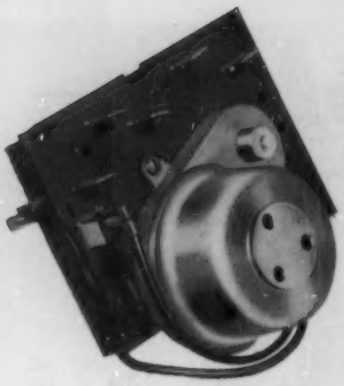
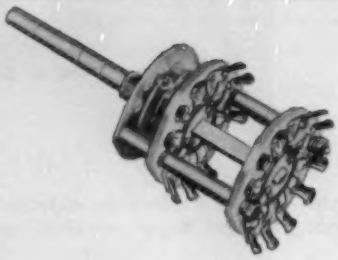
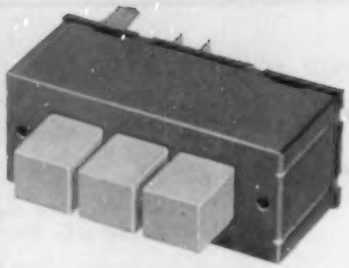


MODEL W TIMER provides sequence control of three circuits for cycles from 32 minutes to 24 hours . . . takes minimum space.

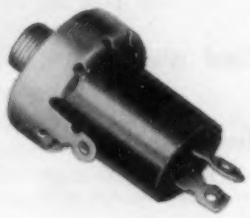


RS ROTARY SWITCHES are available in multi-bank types, with either phenolic or ceramic insulation; up to 12 positions per section.



PUSHBUTTON SWITCHES, with 3 buttons, are ideal for medium power applications.

Standard Mallory Switches Do Many "Special" Jobs . . . Economically



WATERPROOF MILITARY JACK is one of an extensive line of jacks and plugs for test panels, meter circuits, switchboards.

Literally hundreds of switch applications that look "special" can be filled by standard Mallory switches. The reason lies not only in the versatility of the more than twenty basic Mallory designs, but also in the extensive variations that can be built into each.

The switches shown here are just a few of the standard rotary, slide, jack, pushbutton and time sequence control switches that Mallory regularly produces. Each basic type can be produced in numerous variations . . . promptly and economically . . . using readily available tooling.

By utilizing these switches whenever your requirements permit, you can eliminate the delays and expense of custom-engineered designs. And you can be sure your product will have dependable, long-lasting switch performance, that stems from Mallory's experienced design and precision manufacturing which have served leading manufacturers for several decades.

If your product demands switching characteristics of a special nature, Mallory engineers will be glad to develop custom-fitted designs and to produce your individual switch or time sequence control at economical cost. For complete information on available standard and special models, write or call Mallory today.

Expect more . . . Get more from MALLORY

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Electrochemical—Capacitors • Rectifiers • Mercury Batteries
Metallurgical—Contacts • Special Metals and Ceramics • Welding Materials

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MALLORY
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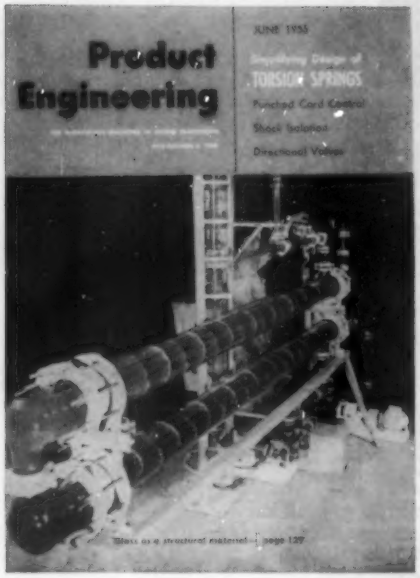

THIS MONTH'S COVER

Although the thermal conductivity of glass is lower than for metals, the ability to resist attack and to present a clean surface to corrosive fluids makes glass a practical material for chemical heat exchangers—as demonstrated in this all-glass heat exchanger under test in the Corning Glass Works Laboratory.

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Product Engineering
A McGRAW-HILL PUBLICATION

June, 1955 Vol. 26, No. 6

Published monthly, with an additional issue in Mid-October, by the McGraw-Hill Publishing Co., Inc., Executive Editorial, Advertising and Subscription offices McGraw-Hill Building, 330 West 42nd Street, New York 36, N. Y. Publication office, 99-129 North Broadway, Albany 1, N. Y. Donald C. McGraw, President; Paul Montgomery, Executive Vice President; Joseph A. Gerardi, Vice President and Treasurer; John J. Cooke, Secretary; Nelson Bond, Executive Vice President, Publications Division; Ralph B. Smith, Vice President, Editorial Director; Joseph H. Allen, Vice President and Director of Advertising; J. E. Blackburn, Jr., Vice President and Circulation Director.

FOR SUBSCRIPTIONS, write to: Subscription Service, 330 West 42nd Street, New York 36, N. Y. Subscriptions are solicited only from executives, engineers and consultants engaged in the design of machinery and other engineered products. Orders must indicate company and position. Allow one month for change in address.

Single copies 50¢. United States and possessions, $5 for one year, $8 for two years, $10 for three years; Canada, $6 for one year, $10 for two years, $12 for three years; other Western Hemisphere and the Philippines, $15 for one year, $25 for two years, $30 for three years; all other countries, $25 for one year, $40 for two years, $50 for three years. Entered as second class matter Aug. 21, 1936, Albany, N. Y. Post office, under act of Mar. 3, 1936, Albany, N. Y.

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Developments

To Watch

ALUMINUM IN FRACTIONAL HORSEPOWER MOTORS. . . .

. . . . is on the increase according to the Appliance Motor Dept. of the General Electric Co., DeKalb, Ill., whose most recent studies have been in the field of aluminum magnet wire and aluminum bearings. Although G.E. has been using this aluminum wire in motors since 1950, they just revealed that the two main motor performance difficulties, that of lower efficiency and lower starting torque per ampere, can be improved and made equivalent to copper wire performance by proper redesign of the magnetic sections of the motor. To get equivalent performance, indications are that the size of the rotor must be increased about 25 percent, and the stator slot area about 30 percent. Equivalent copper wire winding designs are necessary for each aluminum wire design because few service shops are set up to re-wind motors with aluminum magnet wire. This has given versatility to some motor manufacturers, because production can shift from one winding material to the other during long periods of material allocations or shortages. Aluminum to aluminum, and aluminum to copper connections are made by a carbon arc battery method of fusing the two wires together. To make the aluminum magnet wire to copper lead wire joints mechanically strong, an aluminum ferrule is crimped around the wires before fusing. Aluminum alloy bearing inserts have good characteristics under test conditions with high side loads and mis-aligned end shields.

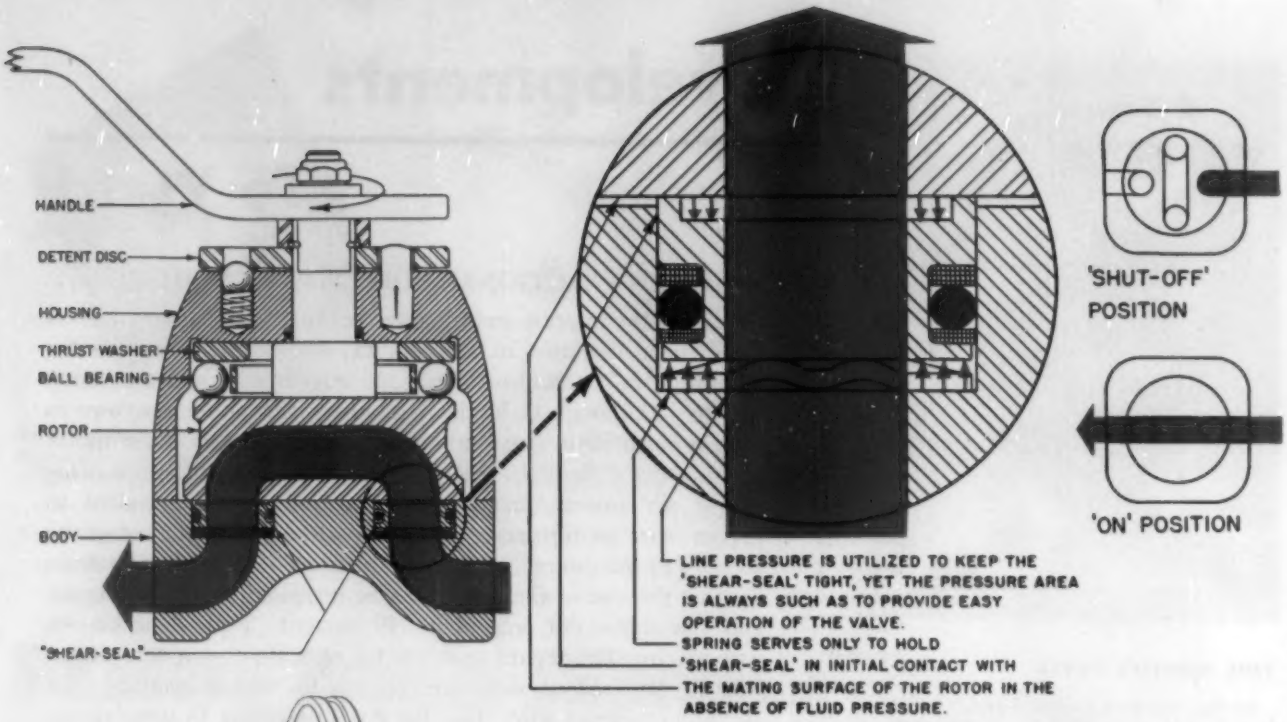
PLASTIC WINGS FOR GUIDED MISSILES. . . .

. . . . and aircraft appear to be possible as a result of a new fabricating technique for reinforced plastic developed by the Cornell Aeronautical Lab., 4455 Genesee, Buffalo, N. Y. An eight-foot aluminum wing for Glenn L. Martin's KDMI guided missile was replaced with a plastic wing and brought favorable test results. The plastic wing weighs 6 percent less than the honeycomb-aluminum skin version, with the man-hour time reduced by 30 percent. Cornell Lab. claims that the new technique shows good results at operating temperatures of 300 to 400 F. The technique involves foaming a low density, high strength plastic core inside a mold and then applying a resin-impregnated glass fabric skin. It is foamed into place, eliminating several operations.

A GREATER RANGE OF INFRARED RAYS. . . .

. . . . can be transmitted by a new glass made from the oxides of antimony. Ordinarily, glasses are based on silicon, but these glasses do not transmit the longer infrared rays. Developed at the Battelle Memorial Institute, 505 King Ave., Columbus 1, Ohio, the new antimony oxide glass, which includes oxides of aluminum and the alkali metals as stabilizing agents, will transmit approximately one-third more of the infrared spectrum. Also, light rays longer than those absorbed by water vapor are also transmitted by the new glass. Possible uses are for analytical equipment and special optical systems.

(*continued on page 7*)


HANDLE
DETENT DISC
HOUSING
THRUST WASHER
BALL BEARING
ROTOR
BODY
"SHEAR-SEAL"
'SHUT-OFF' POSITION
'ON' POSITION
LINE PRESSURE IS UTILIZED TO KEEP THE 'SHEAR-SEAL' TIGHT, YET THE PRESSURE AREA IS ALWAYS SUCH AS TO PROVIDE EASY OPERATION OF THE VALVE.
SPRING SERVES ONLY TO HOLD 'SHEAR-SEAL' IN INITIAL CONTACT WITH THE MATING SURFACE OF THE ROTOR IN THE ABSENCE OF FLUID PRESSURE.

THE "SHEAR-SEAL" VALVE PRINCIPLE IS WELL WORTH YOUR STUDY

Cost and hydraulic control of many products have been improved through the incorporation of "Shear Seal" valves. Manual or Solenoid shut-off and selector valves will handle air, oil, water, grease, fuel and gas at pressures ranging from vacuum to 6000 PSI.

The patented "Shear-Seal" principle consists primarily of a pressure balanced, self-aligning, tubular valve seat, the "Shear-Seal," constantly in perfect contact with an optically flat porting disc, or rotor. The porting disc, or rotor, contains flow passages which are oriented by rotation of the rotor. Mating surfaces of the "Shear-Seals" and rotor are lapped to a five micro inch finish and are checked with monochromatic light waves to assure optical flatness within one light band per inch.

Rugged marcel compression springs maintain intimate contact at all times between the self-aligning "Shear-Seal" and the optically flat rotor. Positive leakproof closure is accomplished by means of this marcel spring, plus a predetermined hydraulic force on the "Shear-Seal." Thus, the higher the pressure, the tighter the seal. This controlled hydraulic load on the "Shear-Seal," in conjunction with large ball thrust bearings, is responsible for the exceptionally low handle load encountered with "Shear-Seal" valves, even at 6000 PSI operating pressures.

Actuation of a Barksdale Valve shears the fluid flow, (hence the name "Shear-Seal") and the square external corner of the "Shear-Seal" face wipes the rotor clean. Thus the sealing surfaces stay clean. Continuous intimate contact of "Shear-Seal" and rotor prevents dirt or foreign particles from entering between sealing surfaces. Dirt might otherwise hold the valve open, as with a poppet, or cause scored sealing surfaces and severe leakage, as with a conventional spool or slide valve.

Fluid flow always takes place through the opening in the center of the "Shear-Seal" rather than across sealing surfaces, (as occurs with a conventional poppet or needle valve). Sealing surfaces of the "Shear-Seal" and rotor are further protected by constant contact with each other. As a result, erosion or "wire drawing" are not experienced with "Shear-Seal" valves, even with extremely dirty, high velocity fluid.

Severe service over a period of years clearly shows that "Shear-Seal" valves improve with use because of the self-alignment and the self-lapping, wear compensating characteristics of the "Shear-Seal." Barksdale Valves actually "wear-in" where others "wear-out."

Long life and low maintenance cost have created wide acceptance in the field—indisputable proof of the soundness of the Barksdale "Shear-Seal" principle.

For the more complete story, visually explained in comic book sequence, write for "Super Seal explains the Shear-Seal principles." Included are some interesting cut-out models which further demonstrate the unusual characteristics of this valve principle.

BARKSDALE VALVES

5125 Alcoa Avenue, Los Angeles 58, California

Send FREE bulletin "Super Seal Explains the 'Shear-Seal' Principle."

NAME _____ TITLE _____

COMPANY _____

ADDRESS _____

CITY _____ ZONE _____ STATE _____

Development to Watch

A NEW APPROACH TO RUST PREVENTION. . . .

. . . .with "vapor phase inhibitors" was announced by the Navy's Bureau of Aeronautics, Washington, D. C., to be successful, on the basis of test results recently received. The rust inhibitors are organic chemicals which when released in a confined space, evaporate slowly, covering all the areas to be protected with a protective powder. Greatest industrial use seems to be in the packaging of ferrous metal spare parts. In the Navy's test, old aircraft engines were stored on tropical islands in the Pacific with the standard preservative oil used on all engines. Some engines were dusted internally with a small amount of a white powder, largely composed of amine nitrates. The fully assembled engines were left uncrated and exposed for two years until severe rusting appeared. In the engines not dusted, this took place after three months. The specially treated engines survived the two year test without needing major repairs to make them operable. The rust inhibitors are not suitable for some applications using non-ferrous metals, for in some cases the surface reaction produced more corrosion than what was to be prevented.

CUTTING DELIVERY TIME OF AIRCRAFT FORGINGS. . . .

. . . .by about 75 percent is possible with a new die technique announced by the Columbus division of North American Aviation, Inc., Columbus 16, Ohio. The new system consists of casting stable forging dies from beryllium copper, and other castable metal alloys. Beryllium copper (and the other alloys) can be used to forge parts of magnesium, steel (alloy and carbon), as well as aluminum. North American's experiments have shown that the dies of these materials will produce sufficient quantities for normal aircraft production runs. With beryllium copper dies, the die finish seems to improve with use because of a self-burnishing that takes place during forging, thus minimizing the use of lubricants.

RECORD STARTING SALARIES. . . .

. . . .of $400 per month are being offered to June graduates of the Columbia School of Engineering. A record 260 companies requested interviews with the 200 available engineering graduates with B. S., M. S., and doctoral degrees. An additional 100 companies sent promotion literature. Electrical engineers and electronics men are in the greatest demand, with chemical and, mechanical engineers next in that order. Aircraft companies want the greatest number, with electronics and chemical industries next. Oil companies are also making a strong bid. Starting salaries for engineers with a masters degree is about $440 per month. More companies are offering summer try-out jobs a year before the student is available. Although no strings are attached to these jobs, about 50 percent of the men later go with that company.

A STABILIZED LIGHT SOURCE. . . .

. . . .with a brillance varying not more than 0.01 percent, operates from conventional house current and can be used in laboratories, and military and industrial applications where a constant light source is required as a reference. Transistors and saturable transformers are used to automatically regulate the flow of current through a lamp to maintain constant filament temperature and current. Changes in the filament voltage are corrected by the control amplifier. A long life mercury battery is used as a reference. Ransom Research, P. O. Box 382, San Pedro, Cal.

(continued on page 9)

Friction Surfaces Need Parco Lubrite

Wear is a problem wherever there is sliding or rolling contact. Parco Lubrite controls wear on metal friction surfaces.

The phosphate coating produced by Parco Lubrite is nonmetallic, provides a separating layer of phosphate crystals that holds lubrication, prevents metal to metal contact during break-in, minimizes scoring and scuffing.

Parco Lubrite is used on shafts, gears, pistons, cylinder liners, valves, rings, and scores of other parts. The inexpensive, simple, quick process gives uniform high-quality results.

The friction surfaces of your product will be improved by Parco Lubrite. Full information is yours on request.

**Bonderite, Bonderlube, Parco, Parco Lubrite—Reg. U.S. Pat. Off.*

Since 1915—leader in the field

PARKER RUST PROOF COMPANY

2179 E. Milwaukee, Detroit 11, Michigan

BONDERITE	BONDERITE and BONDERLUBE	PARCO COMPOUND	PARCO LUBRITE	TROPICAL
corrosion resistant paint base	aids in cold forming of metals	rust resistant	wear resistant for friction surfaces	heavy duty maintenance paints since 1883

Developments to Watch

SYNTHETIC ELASTOMER WITH GOOD RESISTANCE. . . .

. . . .to petroleum and chemical hydraulic fluids which usually impair available elastomers has been announced by the Organic Chemicals Div. of Monsanto Chemical Co., St. Louis 4, Mo. Trademarked Vyram, its most likely use will be for hydraulic packings. The new material is an acrylate type elastomer, and can be easily fabricated into standard packings and gaskets. Besides withstanding the swelling action of many fluids, the new material was found to be unusually resistant to ozone. Main drawback: stiffening at extremes of temperature.

A PORTABLE HYDRAULIC TESTING MACHINE. . . .

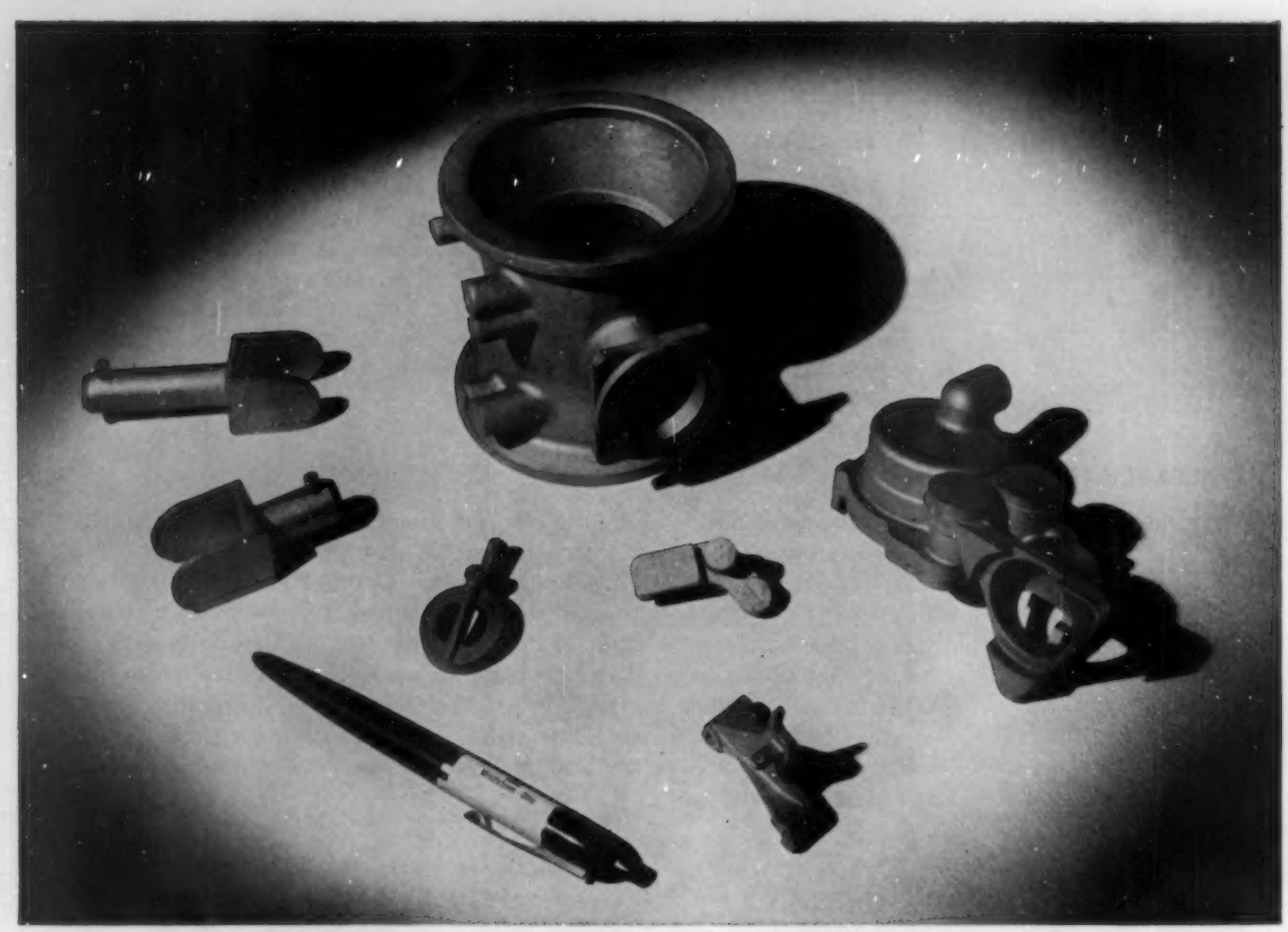
. . . .with a 60,000 lb. capacity in tension and compression can be wheeled through the average size doorway and placed as far as 25 ft. from the control console and indicator. Built by the Baldwin-Lima-Hamilton Corp., Philadelphia 42, Pa., it has a feature of being able to apply both tension and compression in a common testing space over a fixed table 24 in. above the floor. A double-acting Emery hydraulic capsule is used in the weighing system which is separate and independent of the hydraulic loading system. The machine has a 34 in. opening for tension tests, not including the stroke. Rate of head motion can be controlled between 0.05 and 15 in. per min. at any load up to 60,000 pounds. Accuracy is within 0.1 percent of scale range.

CERMETS FOR USE IN GAS TURBINES. . . .

. . . .have been reduced to three classes and appear promising for temperatures in the range of 1200 to 2100 F, according to a report by the American Metal Corp., 312 Yonkers Ave., Yonkers 2, N. Y. First, the nickel aluminides show promise for temperatures up to 1600 F. Up to 1800 F, titanium-carbide base cermets look good, while the borides appear useful at temperatures of 1800 to 2100 F. The nickel aluminides are the most ductile and have higher impact strength; however, their high strength temperature is lower than that of the borides or the titanium-carbide base cermets. The metal borides have the highest high temperature strength. All cermets of these three types are made by powder metallurgy techniques. Resistance to oxidation and heat strength is adequate.

AND IN ADDITION. . . .

. . . .Since its announcement a year ago, the Solar battery developed by Bell Telephone Labs., 463 West St., N. Y. 14, N. Y., has, with recent refinements, doubled its efficiency and now stands at 11 percent. . . . . .The nation's heaviest consumer of molded reinforced plastics parts?—is Chrysler Corp. who is using more than 26 tons of the material each day, mainly for car heater housings; other uses are air vents, station wagon trim, and plastic dies. . . . . .Krupp, the German industrialist, will start operations on the first titanium processing plant on the continent this spring; located at Essen, the plant is ready to produce 3 tons a month of the finished material at a selling price of $43 per kilogram. . . . . .Big rubber producers predict that a completely synthetic tire is only a few years away, and that if things work out as expected, the U.S. will not need any more natural rubber. . . . . .National Bureau of Standards, Washington 25, D.C., has a special insulating seal to solve leakage problems around electrical connections to high pressure vessels; made of inexpensive materials, the seal uses a sapphire bushing to get the high strength and good insulating properties, and has been tested to 170,000 psi.



Stainless castings show up to 190,000 psi strength after 875 F hardening treatment

Foundries report ultimate tensile strength as high as 190,000 psi in investment castings of Armco 17-4 PH Stainless Steel. This precipitation-hardening grade is easy to cast. It fills thin sections and details nicely, surface finish is good and tolerances small.

READILY MACHINABLE Armco 17-4 PH investment castings machine readily to an excellent surface finish. The subsequent 1-hour hardening treatment at 875 degrees F will not distort the part nor damage the surface. It causes only a slight discoloration.

NUMEROUS SUPPLIERS Armco does not make castings. If you are interested in high-strength, low-temperature hardening castings with high corrosion resistance, just fill out the coupon. We'll send you a list of suppliers of investment castings and other types made of Armco 17-4 PH Stainless Steel.

Armco Steel Corporation 1345 Curtis Street, Middletown, Ohio
Send me a list of producers of castings of Armco 17-4 PH Stainless Steel.

Name:_____

Firm:_____

Street:_____

City:_____ Zone:_____ State:_____

ARMCO STEEL CORPORATION 1345 CURTIS STREET, MIDDLETOWN, OHIO

SPECIAL STEELS

SHEFFIELD STEEL DIVISION • ARMCO DRAINAGE & METAL PRODUCTS, INC. • ARMCO INTERNATIONAL CORPORATION

Advanced design shovel-crane uses Link-Belt LXS to transmit power from driving pinion on traveling and steering mechanism. LXS design combines precision with long life.

For heavy-duty, exposed drives -- it's LINK-BELT LXS chain

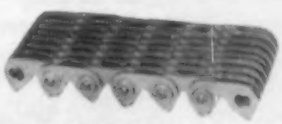
LINK-BELT offers the chain that's best for every drive and conveying job

Accurate sizing of pins, bushings and pitch holes in Link-Belt LXS chains assures a tight fit of mating parts. This plus many other important features promotes longer chain life. That's why they are so widely used for exposed drives subject to repeated heavy loads and high impact.

Similarly, for other types of power transmission and conveying, Link-Belt builds chains with the characteristics required by the job. And it's this completeness of line that gives you the *right* chain for *your* requirements.

Ask your nearest Link-Belt office for the facts on the complete Link-Belt line of chains and sprockets, including roller and silent chain drives.

No ONE chain serves every purpose -- get the RIGHT one from Link-Belt's *complete* line



Link-Belt Silent Chain for smooth, high-speed drives from fractional to thousands of horsepower. Preselected stock drives to 50 hp.

Precision Steel Roller Chain combines high hp with light weight for drives and conveyors. Single and multiple widths, ⅜ to 3" pitch.

Double-Pitch Precision Steel Roller Chain for conveying and power transmission applications.

S-815 flat-top conveyor chain—economical, sturdy, reliable, easy to detach and keep clean.

13,501-B

LINK-BELT

CHAINS AND SPROCKETS

LINK-BELT COMPANY: Executive Offices, 307 N. Michigan Ave., Chicago 1. To Serve Industry There Are Link-Belt Plants, Sales Offices, Stock Carrying Factory Branch Stores and Distributors in All Principal Cities. Export Office: New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville, N.S.W.; South Africa, Springs. Representatives Throughout the World.

WHY ZINC RATES FIRST IN DIE CASTING • NUMBER 3 OF A SERIES

castability — as utilized by PHILCO

These components of the 1955 Philco Roastmeter electric range reveal the wide design latitude possible with ZINC die castings. No other metal or method of production offers product engineers equal freedom of expression with respect to shape, detail and finish.

Consider, for example, two of the castings—the clock face and frame. Not only are these ZINC die castings extremely complex in shape, but the lettering and numerals (both recessed and raised) are sharply defined and the casting surfaces are ready for either plated or painted coatings.

While these attributes of ZINC die castings govern the appearance of the finished product, they also have a decided influence on production costs. The complexity of shape and clean-cut design details minimize the need for secondary operations. And the smooth as-cast surfaces of these ZINC die castings easily take and hold any commercial finish.

Other examples of product engineering with ZINC die castings will be covered in future advertisements in this magazine. Send for our brochure and contact any commercial die caster for the answers to your particular production problems.

Send for your copy

The New Jersey Zinc Company 160 Front St., New York 38, N. Y.

ZINC
FOR DIE CASTING ALLOYS

The Research was done, the Alloys were developed, and most Die Castings are based on

HORSE HEAD SPECIAL (99.99 + % Uniform Quality) ZINC

Here's how LINK-BELT P.I.V. contributes to

automation

of processes requiring variable speed control

P.I.V. can synchronize machine components or complete machines

Wherever efficient speed changing is required for automated processes, the Link-Belt P.I.V. regulated by automatic controls, offers precision matched by no other method. Whether these processes involve tension, volume, synchronization, winding speeds, moisture content, product thickness, or similar requirements, these controls sense variations quickly —compensate for change through the P.I.V. before product quality is affected.

In addition to flexibility, the Link-Belt P.I.V. offers vital performance advantages. Independent of friction, its self-tooth-forming chain meshes with grooved wheels to transmit power with no slip.

For information on P.I.V. and its automatic controls, call your nearest Link-Belt office. Or write for Books 2274 and 2349.

LINK-BELT P.I.V. VARIABLE SPEED DRIVE

LINK-BELT COMPANY: Executive Offices, 307 N. Michigan Ave., Chicago 1. To Serve Industry There Are Link-Belt Plants and Sales Offices in All Principal Cities. Export Office, New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville, N.S.W.; South Africa, Springs. Representatives Throughout the World. 13,044

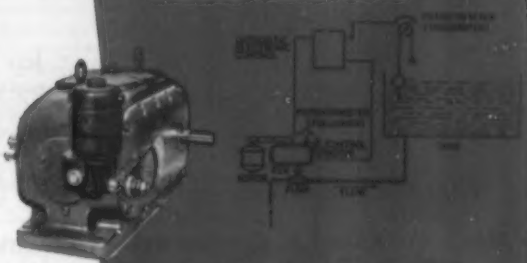
PNEUMATIC

Actuated by air signals in response to pilot-operated temperature or pressure recorder, P.I.V. system regulates rate of coal fed to boiler.

MECHANICAL

Predetermined timing or cyclic speed regulation can be accomplished by P.I.V. with mechanical controls, as well as electric, pneumatic and hydraulic.

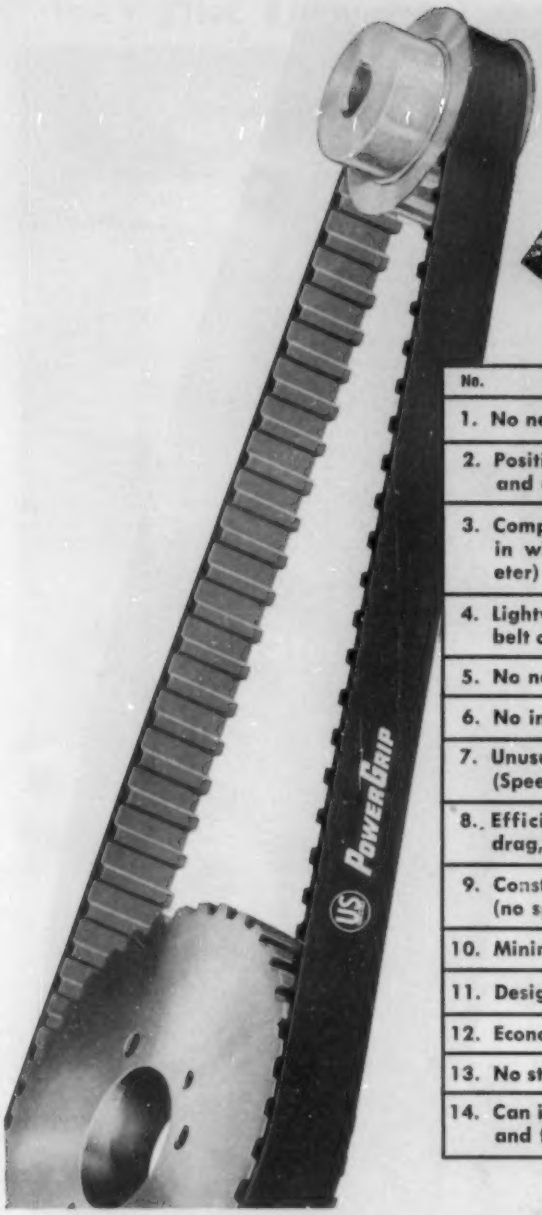
ELECTRONIC



Liquid level in tank is held between desired limits. Float-operated potentiometer signals P.I.V. control system which varies pump speed.

HYDRAULIC

Follower roll controls P.I.V. drive while providing constant-speed winding of material regardless of change in reel diameter.



"√" in your transmission belt needs

No. Advantages	PowerGrip "Timing" Belt	Chain	Gear	V-Belts	Flat Belts
1. No need for lubrication	√				
2. Positive elimination of slip and creep	√				
3. Completely compact (Both in width and pulley diameter)	√				
4. Lightweight (Heavy duty belt only 0.1 lb./ft./in.)	√				
5. No noise or vibration	√				
6. No initial tension	√				
7. Unusual speed range (Speeds up to 12,000 FPM)	√				
8. Efficient (Elim. heat, lube drag, high bearing loads)	√				
9. Constant angular velocity (no speed fluctuation)	√				
10. Minimum backlash	√				
11. Design flexibility	√				
12. Economical	√				
13. No stretch	√				
14. Can it be completely housed and forgotten?	√				

Note that the U. S. PowerGrip "Timing" Belt takes a "√" after every advantage

While every type of drive has certain advantages, *no* type of power transmission possesses *so many* advantages as the U.S. PowerGrip "Timing" Belt drive. For example, *it is the only positive drive that never needs lubrication.*

THE LIST OF USES GROWS DAY BY DAY! Power production machinery in every field is made more efficient, volume of production increased, and maintenance costs lowered with this amazing belt. The list of OEM applications grows too numerous to mention. U.S. PowerGrip has streamlined hundreds of products... made them sell above competition. Some equipment would not be in existence at all, if it weren't for this great belt.

Immediate delivery of stock drives with ratios up to 12 to 1 is obtainable from any of United States Rubber Company's selected distributors or any of the 27 "U.S." District Sales Offices, or the address below.

Send for free illustrated manual, complete with standard drive tables.

"U. S." Research perfects it..."U. S." Production builds it... U. S. Industry depends on it.

UNITED STATES RUBBER COMPANY

MECHANICAL GOODS DIVISION · ROCKEFELLER CENTER, NEW YORK 20, N. Y.

Hose • Belting • Expansion Joints • Rubber-to-metal Products • Oil Field Specialties • Plastic Pipe and Fittings • Grinding Wheels • Packings • Tapes Molded and Extruded Rubber and Plastic Products • Protective Linings and Coatings • Conductive Rubber • Adhesives • Roll Coverings • Mats and Matting

Bridgeport HIGH I.Q.
Silicon Aluminum Bronze Rod

It machines 50% to 70% as fast as free-cutting brass . . . is 9% lighter, 50% stronger than half-hard Naval brass, has excellent corrosion resistance and a tensile strength of 85,000 psi when annealed.

You can profit by using Bridgeport Silicon Aluminum Bronze Rod for high-strength screw machine parts, marine and pole line hardware, valve stems and pump parts, nuts and bolts. Free machining means faster production, longer tool life. High strength means superior wear, top performance.

We'd like to put these advantages to work for you. Our representative will be glad to show you how the *High Inner Quality* of Bridgeport Silicon Aluminum Bronze and other Bridgeport Alloys can help you to product improvement.

BRIDGEPORT BRASS

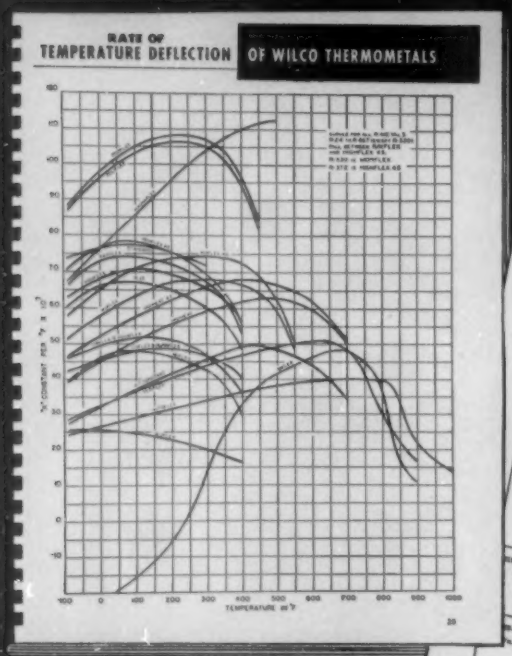
Offices in Principal Cities · Conveniently Located Warehouses

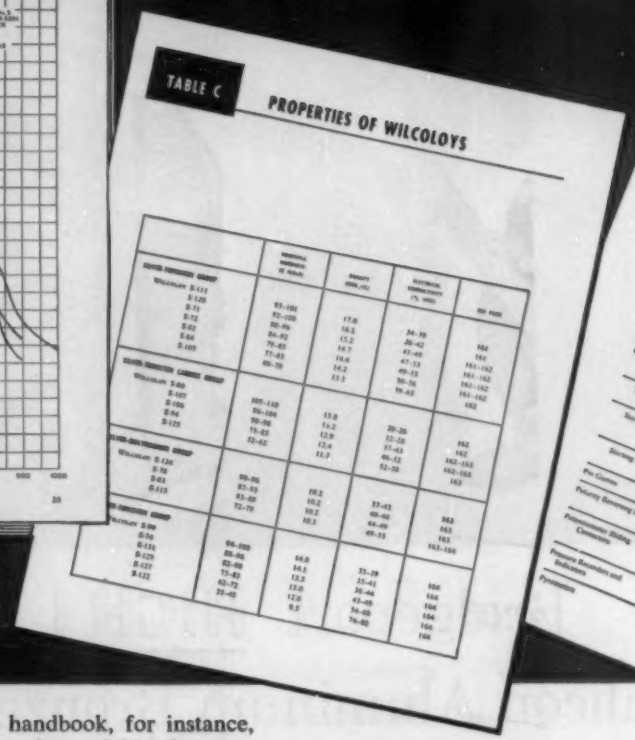
Bridgeport Brass Company, Bridgeport 2, Connecticut · In Canada: Noranda Copper and Brass Limited, Montreal

It's NEW!...

IT'S READY FOR YOU!

The WILCO Blue Book—the most complete reference manual ever written on Thermometals, Electrical Contacts, Composite Metals, and Special Purpose Alloys





It shows you how
It helps you select
It saves you time

In the Thermometals section of this handbook, for instance, are 100 charts to enable you to determine quickly the type, size, shape, and fabrication of the thermometal best suited to your application. Detailed formulae for estimating the behavior in each application save still more of your time.

In 4 Sections for Ready Reference:

1. THERMOMETAL (Thermostatic Bimetals). All temperature ranges, deflection rates, and electrical resistivities,

2. ELECTRICAL CONTACTS, including Silver, Platinum, Tungsten and their alloys—Sintered Powder Metals —Precious Metal Laminated Collector Rings.

3. CLAD AND OVERLAID COMPOSITE METALS (Strip Stock and Wire) with facings of gold, silver, platinum, copper, and nickel. Jacketed wire, silver on steel, copper, invar, and other combinations. Rolled Gold Plate and Goldfilled wire.

4. SPECIAL ALLOYS: Ni-Span C Constant Modulus Alloy; other special alloys, including high strength and high conductivity copper base alloys.

This 192-page "Blue Book" is designed with one chief aim—to save you time. There has never been a reference book on these metals remotely comparable to it for completeness. There is no better way to select the correct material than with the Wilco Blue Book combined with Wilco Engineering Service. Qualified personnel may obtain a copy free by writing on their company letterhead. For advice on a specific problem, ask for Wilco Engineering Service.

WILCO

The H. A. WILSON Company

2655 U. S. Route 22, Union, New Jersey

Branch Offices: Chicago · Detroit · Los Angeles · Providence

Here's the Complete "Package"

for Counting Electrically...

Added Evidence that —

Everyone Can Count on VEEDER-ROOT

This Veeder-Root Reset Magnetic Counter (AC or DC) is actuated through electromagnets. And it may be connected in series with any device having a contact arrangement . . . like the specially designed Veeder-Root Electrical Contactor at the left, which insures positive operation of the counter, either in oscillation or connected directly to a revolving shaft . . . with the counter placed at *any* distance from the machine or process on which the count is required.

This is another one of the hundreds of Veeder-Root Standard and Special Counting and Computing Devices developed for every conceivable counting duty, in every field from atomics to electronics.

What do *you* need to count? Just write:

VEEDER-ROOT INCORPORATED
HARTFORD 2, CONNECTICUT

Chicago 6, Ill. • New York 19, N. Y. • Greenville, S. C.
Montreal 2, Canada • Dundee, Scotland
Offices and Agents in Principal Cities
"The Name that Counts"

MOTOR CONTROL FACTS
ON INDUSTRY'S
MOST COMPLETE LINE

FACT: Here is industry's newest and most advanced high-voltage starter!

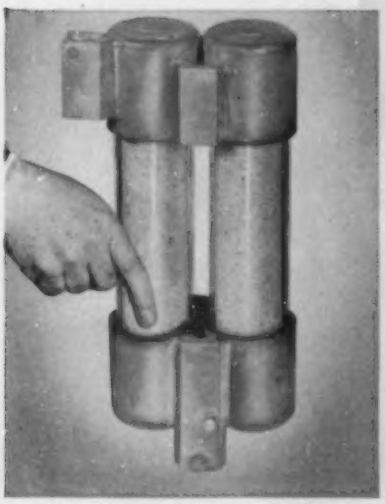
This new line of Westinghouse high-voltage fused starters offers industry more protection — more operating simplicity than any other. Here are a few reasons why:

Extension of the BAL fuse line up to 400 amperes with the first and only 400-ampere, double-barreled, single-unit fuse; a new 50,000-kva air break contactor featuring the most advanced arc interrupting action yet developed; and new enclosures providing new levels of convenience and safety.

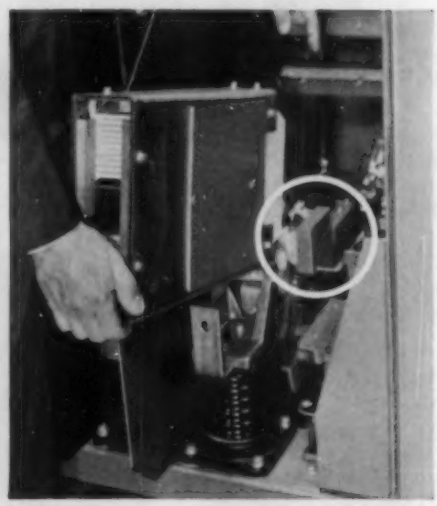
Booklet B-6535 has more facts on this outstanding new starter. Get it from your Westinghouse engineer —or write Westinghouse Electric Corporation, 3 Gateway Center, P. O. Box 868, Pittsburgh 30, Pa.

J-21898

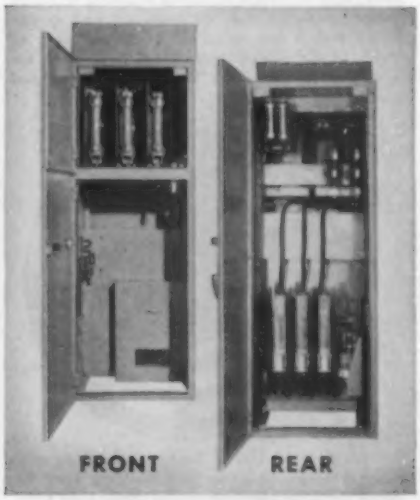
YOU CAN BE SURE... IF IT'S Westinghouse



New 400-ampere, double-barreled, type BAL fuse features "no-bolt" brazed connections which insure equal division of current. Complete coordination of fuses is assured. Exclusive BAL single-barreled design for fuses up to 200 amperes is retained.

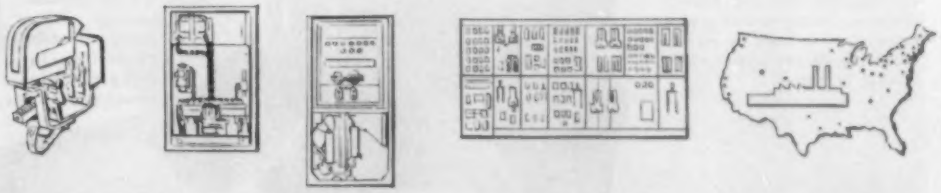


New air break contactor (200 and 400-ampere sizes) features a unique arc chute design which greatly simplifies inspection and maintenance of the contacts. Simply pull the arc chute down —contacts are immediately and conveniently accessible.



New enclosure design provides both mechanical and electrical interlocks; front and rear access DOORS; top-mounted bus arrangements; separate compartmentation of high and low-voltage components—all designed for maximum safety of personnel.

FROM INDUSTRY'S MOST COMPLETE LINE OF INDUSTRIAL CONTROL



CONTROL COMPONENTS • MOTOR CONTROL • ELECTRONIC CONTROL • CONTROL SYSTEMS • NATIONAL SERVICES

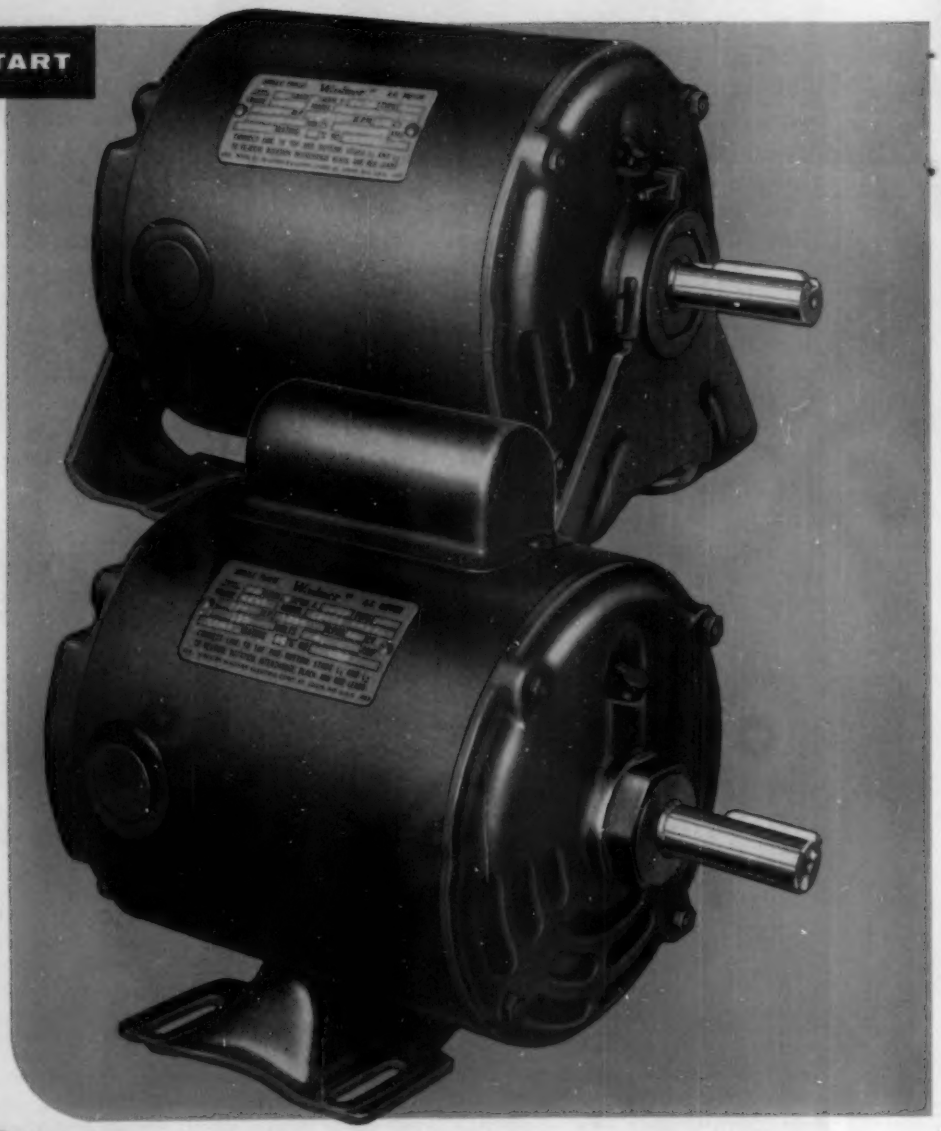
Wagner®
ELECTRIC MOTORS
... the choice of leaders in industry

WAGNER offers

TYPE RK CAPACITOR-START

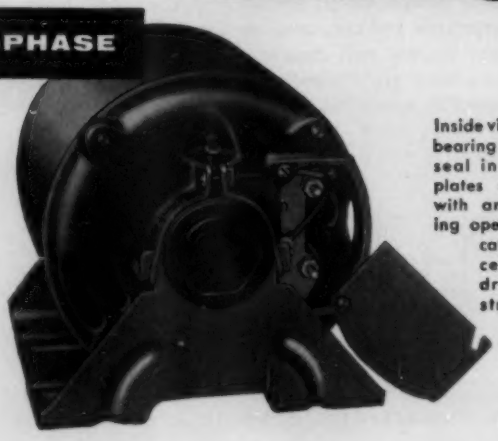
View with endplate removed showing terminal board on which thermal protector and quick-break switch are mounted. Note thickness of steel frame which has been machined for accurate endplate fit. Rigid base is welded directly to the frame.

Inside view of sleeve bearing endplate with seal removed to show felt packing used for lubrication. In addition to the continuous strip, a spring-loaded piece of felt makes constant-pressure contact with the shaft through an opening in the top of the bearing.



TYPE RB SPLIT-PHASE

View from front end of Type RB motor shows how motor is secured in the base by means of latches. The terminal board cover can be opened as shown or removed entirely by merely loosening the two screws which hold it in place.



Inside view of a sleeve bearing endplate with seal in place. Endplates are provided with ample ventilating openings, all located below the centerline fo dripproof construction.

something NEW in small motors

More compact capacitor-start and split-phase motors—¼ hp and below—

that help the design engineer in a tight spot!

For design engineers who've been looking for efficient fractional horsepower motors with less bulk... here's good news!

Now, you can get smaller, more compact Wagner capacitor-start and split-phase fractional horsepower motors with many new added features such as *a new endplate design, a new lubrication system and a new terminal board and switch location.*

Yet these re-designed motors retain all of the proven features that have made Wagner motors famous for quality for more than 60 years.

BUT CHECK THESE NEW FEATURES

NEW ENDPLATE DESIGN—Endplates are flatter, shallower, with no protruding oil reservoir, terminal board housing or protector compartment, making possible a reduction in the length of the motor. Ample ventilating openings are located below the centerline for dripproof construction.

NEW LUBRICATION SYSTEM PERMITS ALL-ANGLE MOUNTING—Sleeve bearing motors are oil lubricated by means of felt packing, cut to specified shapes and inserted in a specially designed bearing housing. This method insures a constant supply of oil to the bearings at all times, no matter how the motor is mounted.

NEW TERMINAL BOARD AND SWITCH LOCATION—The terminal board is mounted inside the stator frame, making possible a more compact motor. The quick-break switch and the thermal protector are fastened to the terminal board to eliminate all internal connections to the endplate.

When you specify Wagner Motors—you get the advantage of a liberal warranty... of nationwide service facilities, with on-the-spot service, replacement motors and parts available from 24 Wagner-owned Service Branches and more than 850 Authorized Service Stations. You can choose from a wide variety of types and sizes—singlephase or polyphase—from 1/125 to 400 horsepower.

TYPES AND RATINGS IN THE NEW DESIGN

Single-Phase, 60 Cycles, 1725 RPM. ¼ Horsepower and Smaller. Type RK—Capacitor-Start Induction. Type RB—Split-Phase Induction. Available in sleeve bearing or ball bearing models, with rigid or resilient bases.

Bulletin MU-200 gives complete information—write today for your copy.

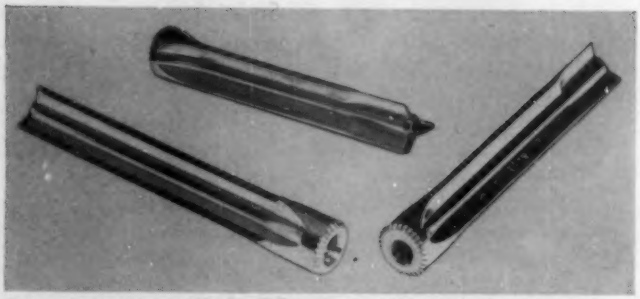
WAGNER ELECTRIC CORPORATION
6406 Plymouth Ave. • St. Louis 14, Mo., U. S. A.

ELECTRIC MOTORS • TRANSFORMERS • INDUSTRIAL BRAKES
AUTOMOTIVE BRAKE SYSTEMS — AIR AND HYDRAULIC

BRANCHES IN 32 PRINCIPAL CITIES

WIDE ENDURO BELT ...keeps scratches off bandages

CORROSION RESISTANCE IN TUBULAR FORM. Republic's Steel and Tubes Division turns out miles of ENDURO Stainless Steel Tubing for the process industries and for mechanical applications. Republic ELECTRUNITE Stainless Steel Tubing and Pipe offer the identical high mechanical and corrosion-resisting properties demonstrated in sheet form by the Reynolon belt. Call Steel and Tubes for application assistance on all your fluid handling and tubing problems.



WHAT'S EVEN MORE CORROSION-RESISTANT? REPUBLIC TITANIUM. Titanium surpasses even stainless steel in resistance to many severe forms of corrosion. Yet, it weighs only 56% as much as alloy steel. Here, Republic Titanium supplies corrosion-resistance and lighter weight to parts designed to knit human bones. Republic Titanium and Titanium alloys now are available for civilian applications. Republic has the experience to help you use them best. Write us.

REPUBLIC STEEL

REPUBLIC STEEL CORPORATION
3150 East 45th Street,
Cleveland 27, Ohio

I'm interested in additional information on:

- ☐ Republic ENDURO® Stainless Steel
- ☐ Stainless Metallurgical Assistance
- ☐ ELECTRUNITE® Stainless Steel Tubing
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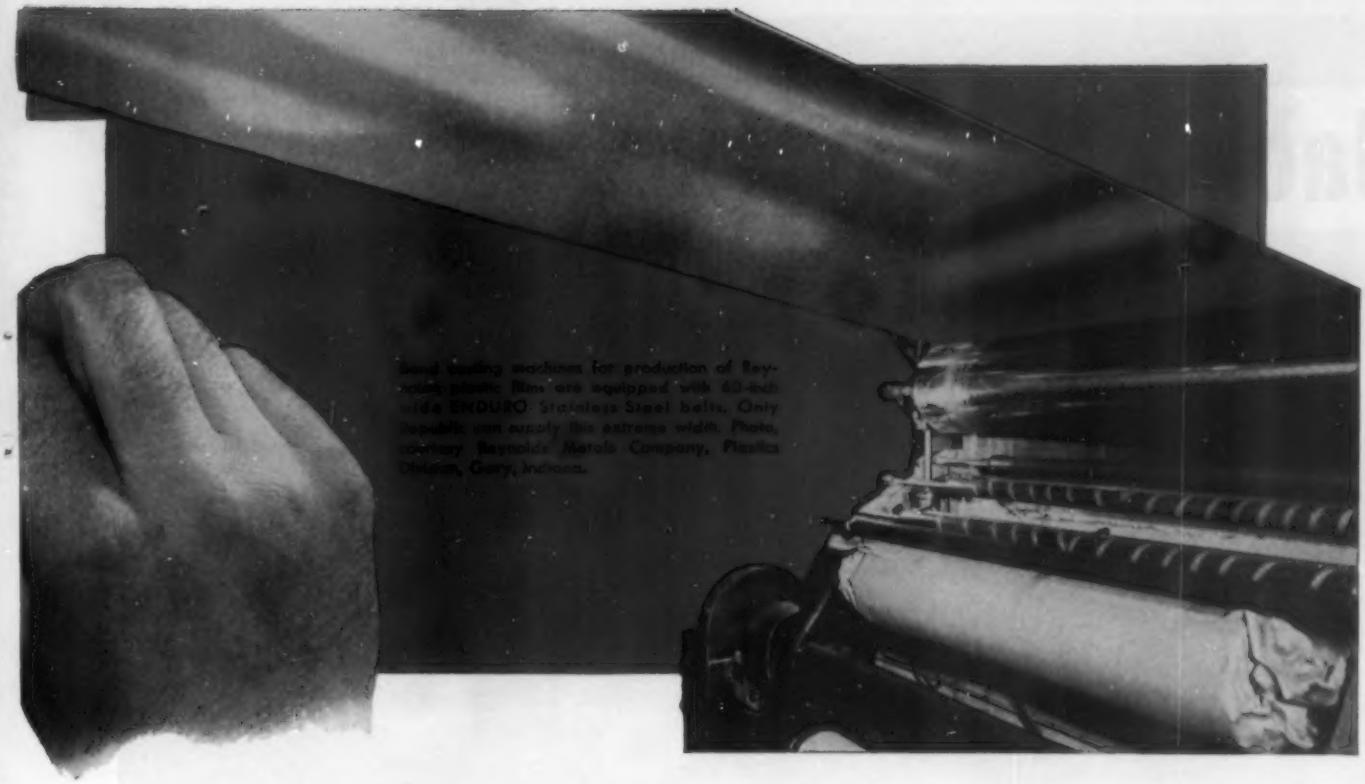
NO CONTAMINATION—NO SPOILAGE. Republic Steel offers a full range of barrels, drums and pails in a variety of metals and finishes to protect your chemical, food and other products. Choose from ENDURO Stainless Steel, hot dipped galvanized steel, hot dipped tinned steel, mill galvanized sheet steel, hot rolled open hearth steel, plain or lacquer lined. Choice of gages to meet all handling and shipping requirements. Many styles in sizes up to 55 gallons. Contact Republic.



This wide, polished ENDURO Stainless Steel belt carries Reynolon plastic coatings in process. One such type makes the peel-off backing for those handy packaged small bandages you use.

The ENDURO surface provides a high luster finish! Since the slightest scratch would be "mirrored" or duplicated in the finished product, the quality of the stainless steel surface determines the quality of the plastic coating. Here, ENDURO keeps scratches off bandages!

Note that the belt is supported only by top rollers. That allows both sides to carry the plastic material . . . speeds production. It also means that the belt must have great tensile strength. ENDURO supplies that strength. In this case, tension on the belt runs as high as 90 tons.

What's more, this belt must be heat-resistant. In process, material passes through 600° ovens. And, many of the plastics processed are in hydrous or acidic solutions. So, the belt must resist rust and corrosion. ENDURO does just that.

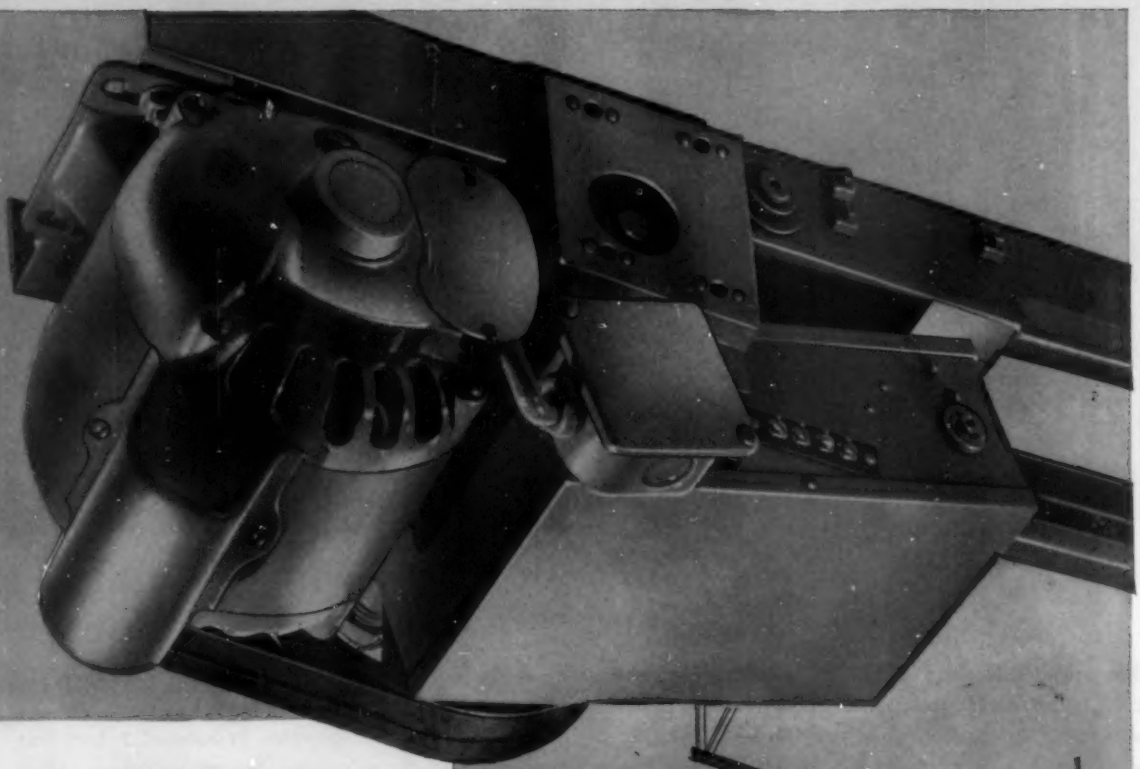
Four of these sixty-inch wide belts help produce Reynolon plastic film. Even at this extreme width, the belts must stay flat. "Crowned" metal could snap like an oil can and damage the plastic.

Republic metallurgists worked closely with Reynolds Metals Company, Plastics Division, to develop this unusual equipment. If you have process or product problems involving heat, corrosion, surface finish or strength, ENDURO Stainless Steel quite likely is your answer. Republic metallurgists will help you apply it most profitably. Write Republic.

REPUBLIC STEEL

World's Widest Range of Standard Steels and Steel Products

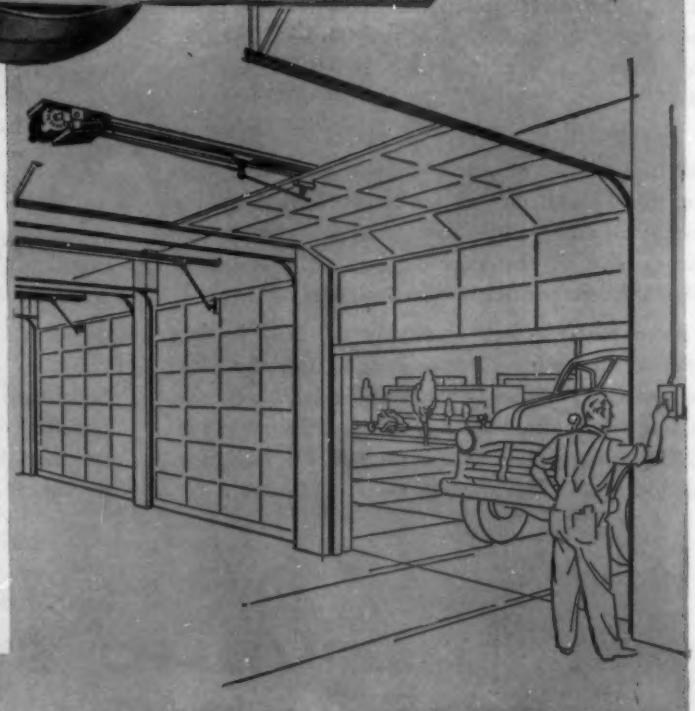
Jack & Heintz Motors answer



HERE WAS THE NEED

Overhead Door Corporation, Hartford City, Ind., one of the world's largest manufacturers of upward-acting garage doors, offer a complete line of electric door operators for residential, commercial and industrial use. To fulfill rigid requirements for added features, their engineers demanded specially designed motors.

These motors had to assure fast, dependable starts — quick, positive stops—instant reversing without hesitation or drift. Their design had to guarantee efficient performance under every condition. For these reasons, Overhead Door turned to Jack & Heintz.



Customized ELECTRIC

toughest job requirements for

THE "OVERHEAD DOOR" TRADE MARK

Provide the many *extras* required for top-flight door operation!

Because electric motors must do far more than *power* the push-button or electronically controlled operators made by Overhead Door Corporation, Jack & Heintz motors are designed specifically for each requirement of the application.

These motors must operate smoothly, quietly, surely—one or one thousand times a day—regardless of climate or temperature extremes. In addition, they are *customized* to work in restricted mounting locations... and provide *extra* features that guarantee years of trouble-free door operation.

Instant Reversing!
No hesitation or drift! Simplified control circuits are achieved by the specially designed Jack & Heintz 3-wire motors.

Positive, Dynamic Braking!
For cushioned, controlled stops preventing shock damage to door or track. Special electric circuit assures this desired performance.

High Starting Torque!
Equally effective in either direction. Special winding design provides maximum power at the start, minimum current demand.

Customized Configuration!
Capacitor, relay, terminal box, end bell and name plate are all ingeniously positioned to customer's exacting service and installation requirements.

DESIGN YOUR PRODUCT TO DO A JOB...

not to fit a motor

Avoid compromising your product design by taking advantage of an engineering philosophy that will answer your special motor needs. Design your product to do a job... not to fit a motor! Write Jack & Heintz, Inc., 17627 Broadway, Cleveland 1, Ohio.

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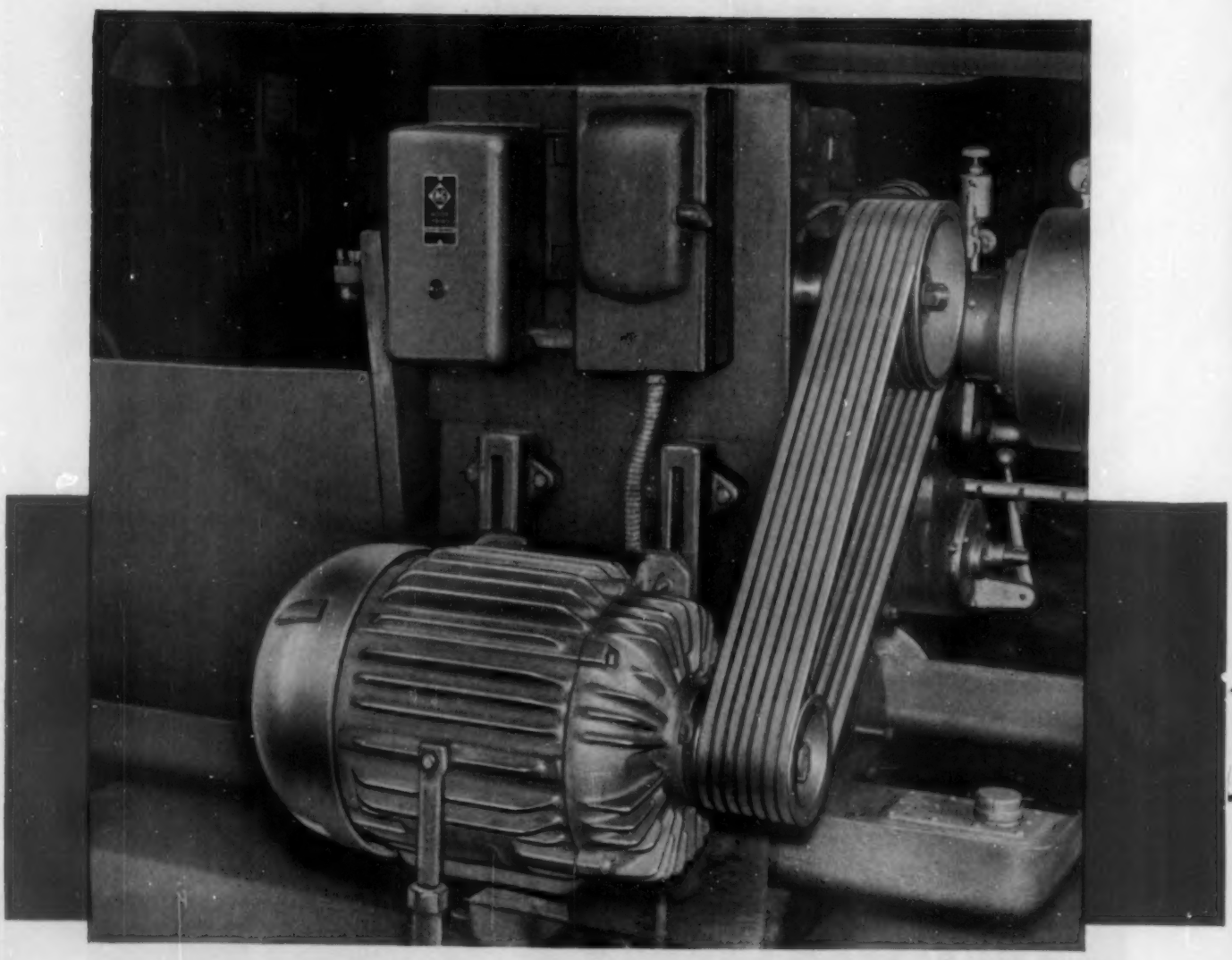
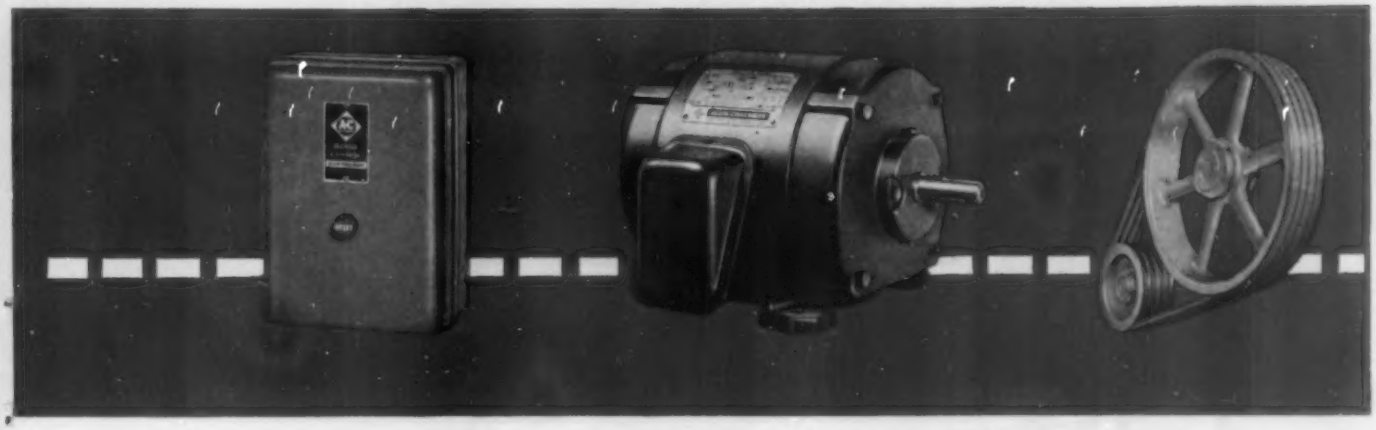
MOTORS *by* JACK & HEINTZ

Use this Combination of Control-Motor-Drive

Save Engineering



ALLIS-



...Simplify Service

These Components are Designed to Work Together and They're Backed by Nation-Wide Service

Save design time, cut manufacturing costs using Allis-Chalmers matched motors, control and V-belt drives. You're sure of efficient power train design when you use coordinated components . . . all of one manufacture. Engineering and matching of parts is done for you by Allis-Chalmers.

Get Nation-Wide Service. Allis-Chalmers contin ues to serve you after your equipment is installed. In addition to 76 district offices, there are almost one hundred Certified Service Shops located in every industrial area in the country. These shops are carefully selected, independent shops that use only factory-approved parts and methods in servicing Allis-Chalmers equipment.

For an experienced specialist to help you select the best drive for your machine . . . for coordinated equipment . . . call your nearby A-C District Office, or write Allis-Chalmers, Milwaukee 1, Wisconsin.

Send for FREE engineering literature

Control

Handy Guide to Starters	14B7733
Reduced-Voltage Starters	14B7215

Motors

Handy Guide to Motor Selection	51B6052
Squirrel-Cage Motors	51B6210
TEFC Motors	51B7225

Texrope Drives

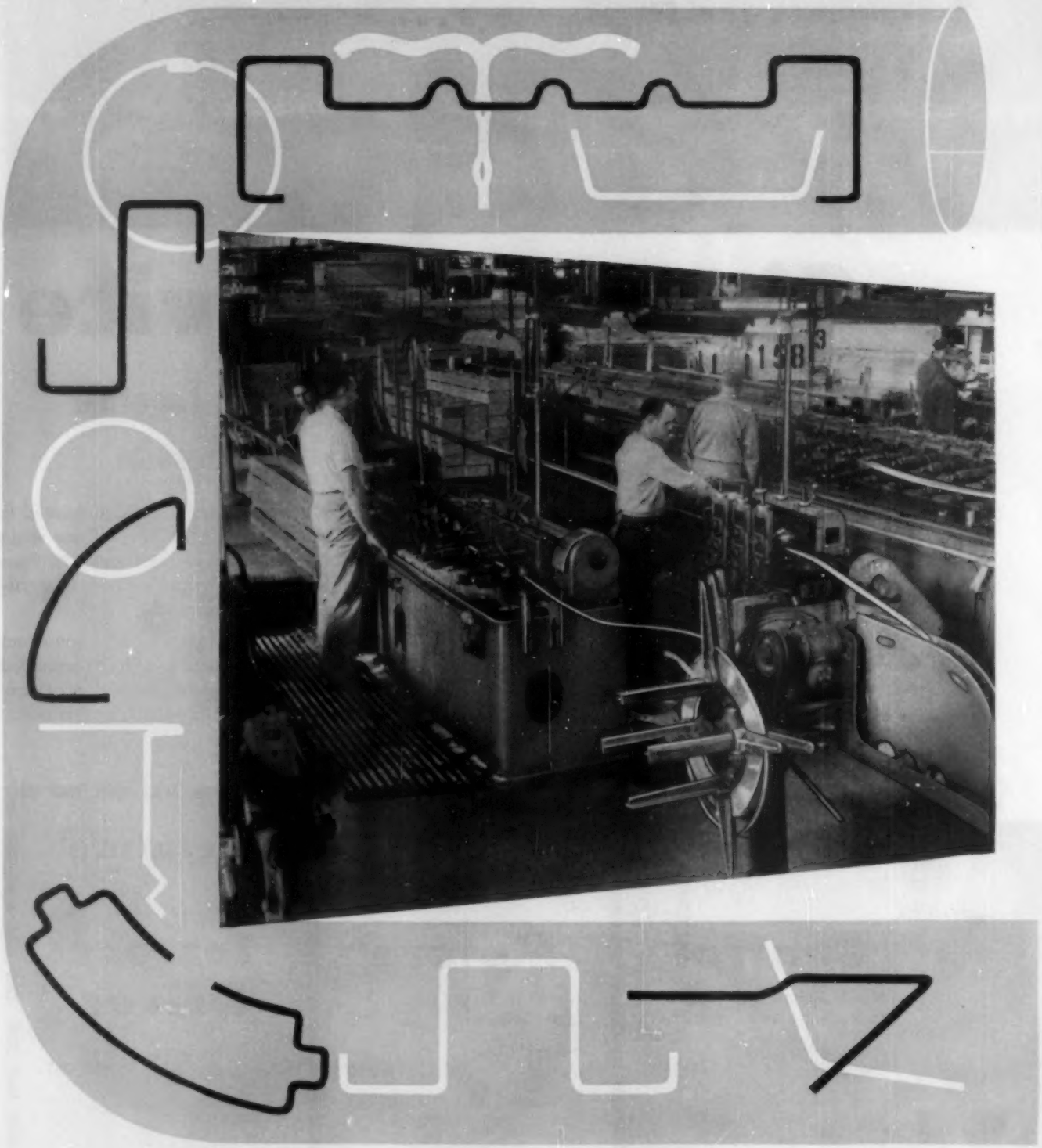
Handy Guide to *Texrope* Drives	20B6051

CHALMERS

Texrope is an Allis-Chalmers trademark.

A-C ALLIS-CHALMERS

For Economy, Design Freedom,



REYNOLDS ALUMINUM

BLANKING • EMBOSSING • STAMPING • DRAWING • RIVETING • FORMING

Dimensional Accuracy and Better Finishes...Specify

ALUMINUM Roll Formed Shapes from REYNOLDS

Rolling from coil stock permits savings that are impossible when working from flat sheet.

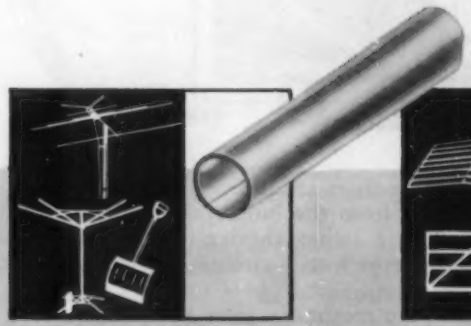
Therefore if you are fabricating a complex shape from flat sheet, or if you require a shape in long lengths, it will pay to switch to aluminum roll formed shapes from Reynolds.

Reynolds roll forming can produce a wide range of easily fabricated shapes that aid in design flexibility. Closer tolerances on Reynolds roll formed shapes mean dimensional accuracy; better as-fabricated finishes often mean a more attractive product without additional finishing operations.

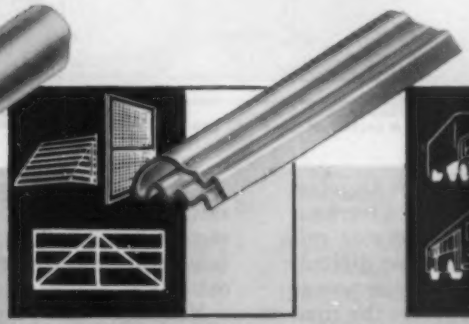
Reynolds sizable investment in roll forming machines and tooling, Reynolds technical advisory service and Reynolds quality control from mine to finished product assure prompt, economical production of quality roll formed shapes. For details, contact the Reynolds office listed under "Aluminum" in your classified telephone directory or write *Reynolds Aluminum Fabricating Service, 2051 South Ninth St., Louisville 1, Ky.*

Write for your free copy of the 8-page brochure, "Aluminum Roll Formed Shapes by Reynolds."

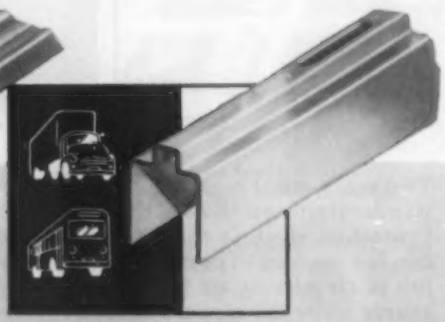
See "Mister Peepers", starring Wally Cox, Sundays on NBC-TV



High strength and superior finish of aluminum roll formed tubing pays off in TV antenna, snow shovel handles, clothes dryers and many other products.



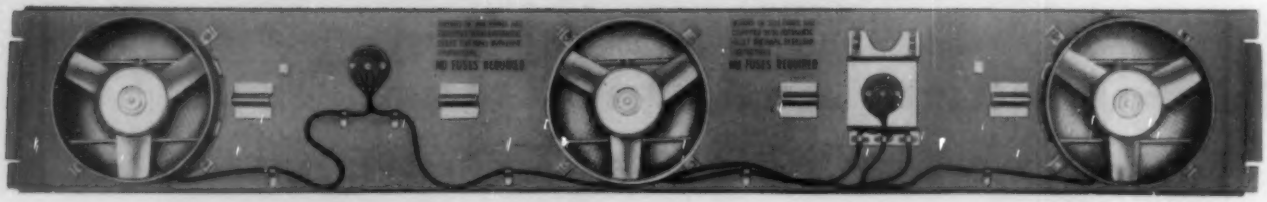
Parts for window screens, farm gates, car ports, awnings and other building products are economically produced with aluminum roll formed shapes.



Many complex truck and trailer framing members, bus trim strips and other parts are easily fabricated with aluminum roll formed shapes.

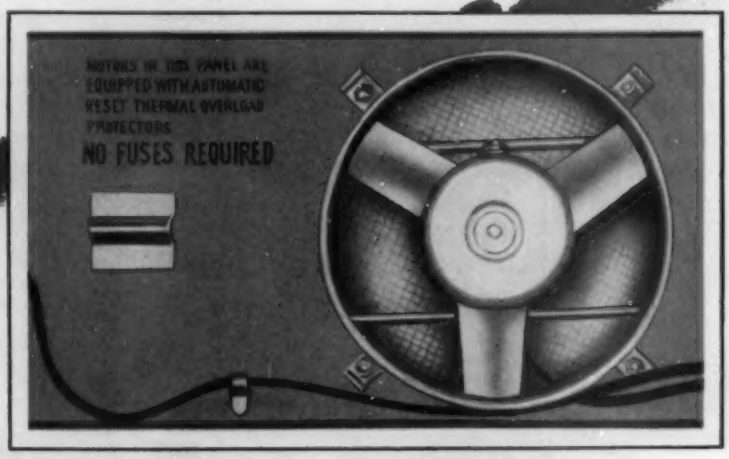
FABRICATING SERVICE

ROLL SHAPING • TUBE BENDING • WELDING • BRAZING • FINISHING



"Since the Change-Over to KLIXON Protectors, Service Problems have been drastically reduced and inconvenience of Stocking and Servicing of Fuses has been completely eliminated."

PRECO, Incorporated



A section of the Preco Fan panel illustrating one of the fans.

Two years ago, Preco Incorporated, Los Angeles, standardized on KLIXON Inherent Overheat Protectors in their three-phase refrigerator rail car fan motors. These are used in the difficult job of circulating air from an axle driven power source while the cars are in motion over the road bed. Previously fuses were used for motor protection.

Since the change-over, the stocking of fuses is no longer required and the former inconvenience and expense to the car lines of servicing burned out fuses has been completely eliminated.

Preco fans are installed in the upper part of the refrigerator car bulkhead. Each three-phase fan motor contains two built-in automatic reset KLIXON Protectors which are so connected that they fully protect all three windings against damage from overheating under all operating conditions.

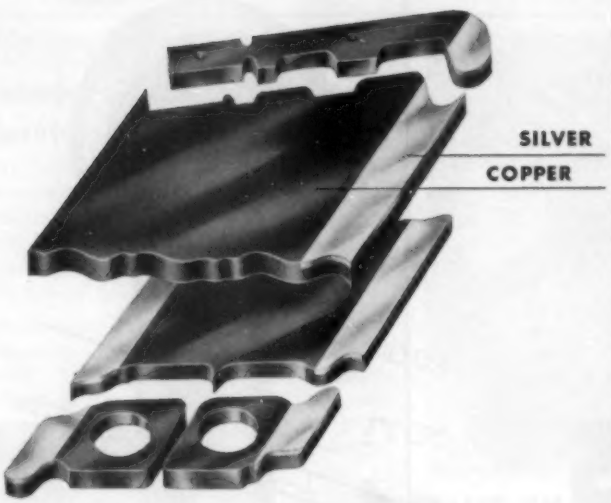
Even when these motors are jammed by ice or salt that spills over from the bunkers, full protection is afforded . . . when the ice jam melts, fans restart and restore air circulation automatically.

You, too, can keep motors in your equipment operating. Reduce service calls and repairs by specifying and using KLIXON protected motors. The additional cost is low, pays for itself over and over by reducing motor burnouts.

KLIXON

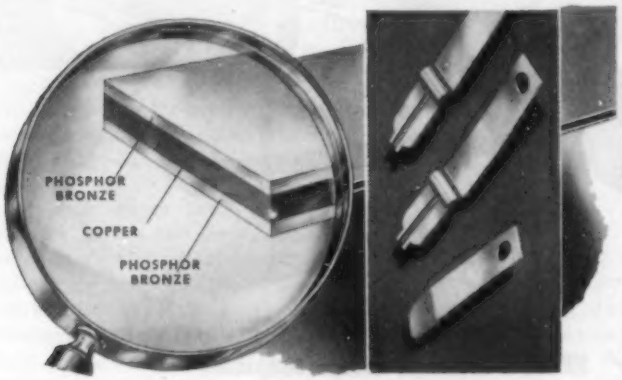
METALS & CONTROLS CORPORATION
SPENCER THERMOSTAT DIVISION
3206 FOREST STREET, ATTLEBORO, MASS.

HERE'S HOW
GENERAL PLATE
COMPOSITE METALS
Cut Scrap, Increase Production, Reduce Costs and Provide Superior Performance

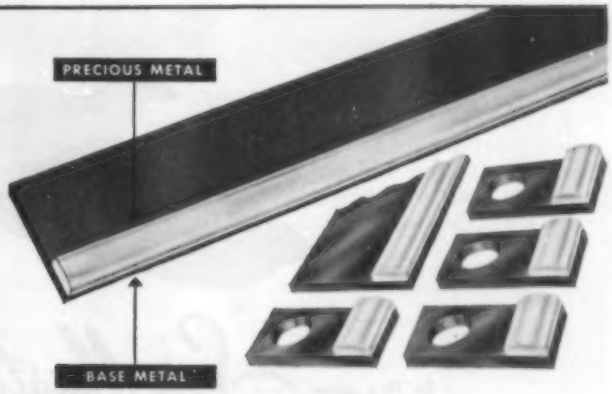


General Plate reduces fabrication and assembly costs of electrical switch contacts.

General Plate composite metal, coin silver clad to phosphor bronz, reduces material waste and manufacturing costs of electrical contact spring clips.



General Plate BRONCO provides higher electrical conductivity without increasing cross-sectional area of spring blades.*



General Plate TOP-LAY® provides quicker fabrication and longer wearing qualities in contact assemblies.

General Plate Composite Metals are improving performance and cutting costs for manufacturers of many types of products.

Made by metallurgically bonding one metal to another, they are available in sheet, strip, tubing or wire in various widths, thicknesses and diameters.

Composite base metals provide a new group of engineering material with properties not available in solid metals. Their use frequently results in lower production costs as compared to solid metals.

In many applications further economy results when General Plate supplies fabricated parts ready for assembly into your product. General Plate makes an infinite variety of fabricated parts, such as electrical contacts, collector rings and TRUFLEX® Thermostat Metal elements to customers' exact specifications.

General Plate Engineers will gladly help you with your design details. Write for Catalog PR700.

*Trademark

You can profit by using General Plate Composite Metals!

METALS & CONTROLS CORPORATION
GENERAL PLATE DIVISION
16 FOREST STREET, ATTLEBORO, MASS.

advanced thinking at

MARTIN...

uses the efficient

HEIM

Unibal

ROD ENDS

in the new *Sea Master* XP6M-1 multi-jet attack seaplane.
Built for the Navy at Martin's Middle River plant, the big, swept-wing
flying boat is powered by four jet engines, and is designated in the over 600
mile-per-hour class. Four Allison J-71 jet engines are equipped
with afterburners to give the craft additional speed and power.

The Heim Unibal consists of a single ball, revolving in bronze bearing inserts, in an outer member of carbon steel, approved aircraft steel, or any other suitable material. They are used extensively by the aircraft industry, and were chosen by Martin for use in the fabulous, new Sea Master for their strength, efficiency, and dependability.

Heim Unibal Rod Ends are manufactured in many sizes to cover a variety of applications, other than in the aircraft industry, and fill a long-felt need for a bearing that corrects misalignment conditions, and has maximum carrying capacity because of their greater surface supporting area. They will take a greater radial and axial thrust load.

Tell us your bearing problem, and our Engineering Department will be pleased to submit their recommendations for any application.

THE HEIM COMPANY
FAIRFIELD, CONNECTICUT

DOW CORNING CORPORATION

Silicone News

FOR DESIGN ENGINEERS No. 17

Editorial

Founder Celebrates 25 Years' Service To Silicone Industry

In 1930, Dr. J. F. Hyde first started his investigations into the field of organosilicon chemistry. His work, which preceded that of any other chemist in this country, led to the first commercial production of silicones.

Frank Hyde received a master's degree in chemistry from Syracuse University in 1924. He then enrolled in the graduate school of the University of Illinois and received his Ph.D. in organic chemistry in 1928. To pursue still further his interest in basic organic chemistry, he spent two years as a post Doctorate Fellow at Harvard University under Dr. J. B. Conant.

DR. J. F. HYDE

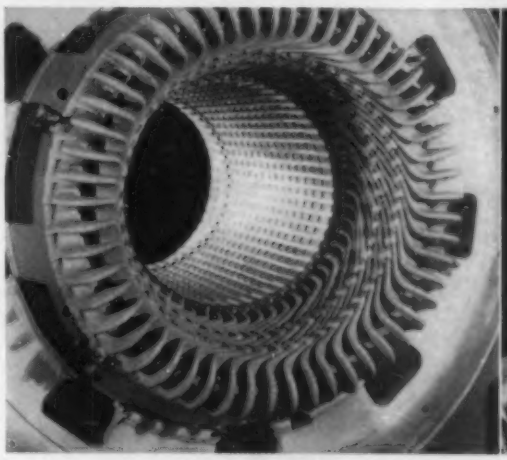
Hyde's work in the field of silicone chemistry began the day he was hired by Dr. E. C. Sullivan of Corning Glass Works in 1930. His first project was to explore the possibility of incorporating organic chemical groups into glass compositions to increase their shock resistance and flexibility. His investigations led deep into the work done by Prof. F. S. Kipping of Nottingham University (England) in the field of organosilicon chemistry. Applying his creative imagination to Kipping's findings, Hyde produced silicone polymers with the very properties that so rapidly propelled the silicones into almost every phase of American industry.

Frank Hyde carried on basic exploratory work in the silicone field at Corning until 1951. He then transferred his laboratory to Midland, Michigan, to be closer to actual silicone operations at Dow Corning Corporation where he continues to apply his research ability to producing more and better silicone products.

At this time, many people join us in saying:

CONGRATULATIONS TO THE MAN WHO WAS FIRST IN THE WORLD TO PRODUCE A USEFUL SILICONE AND ON WHOSE WORK AN INDUSTRY WAS FOUNDED

DR E C SULLIVAN

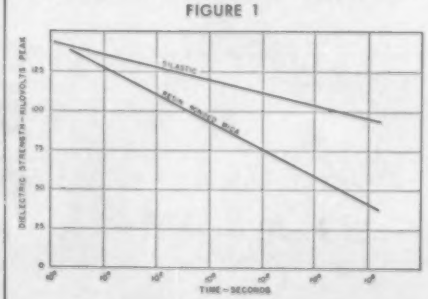


ALLIS-CHALMERS ANNOUNCES ALL-SILICONE-RUBBER INSULATION FOR LARGE MOTORS AND GENERATORS

Allis-Chalmers Manufacturing Co. has announced development of the first all-silicone-rubber electrical insulating system for large motors and generators. Known as Silco-Flex, this new Class H insulation increases the life and efficiency of rotating electric machines by providing greater overload protection and maximum resistance to abrasion, moisture, shock and vibration.

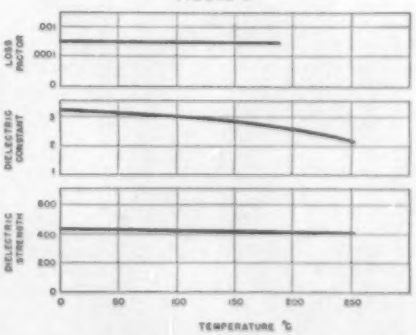
Made with Silastic, the Dow Corning silicone rubber, Silco-Flex is dielectrically superior to all types of resinous insulations. For example, the time-voltage curves in Figure 1 show that the silicone rubber system is remarkably constant compared with a resin bonded mica combination. Breakdown strength of the mica combination drops from about 127 to 27 kilovolts while the breakdown strength of Silco-Flex only decreases from 145 to 90 kilovolts after exposure to the same voltage stress for the same length of time.

FIGURE 1



The dielectric life of the all-silicone-rubber system, after accelerated aging at 250 C, is far better than that of any conventional insulating material. As shown in Figure 2, dielectric strength of 1/16 inch slabs cured 24 hours at 250 C remains practically constant over a temperature span ranging from 0 to 250 C. Dielectric constant decreases gradually from 3.2 at zero to 2.2 at 250 C.

FIGURE 2



In manufacturing Silco-Flex insulated stator coils, Silastic is applied to the conductors and vulcanized into a homogeneous mass by the application of heat and pressure. This produces a continuous and impervious dielectric barrier which provides a flexible, moisture and heat resistant wall over the entire coil structure including leads.

Previous use of silicones in rotating electric machines has been generally limited to

(Continued pg. 2)

FOR DATA RELATING TO THESE ARTICLES, CIRCLE REFERENCE NUMBER IN COUPON ON NEXT PAGE

MORE

Silicone News

DOW CORNING PUBLICATIONS ON NEW DEVELOPMENTS AND TECHNICAL DATA . . .

Temperature stable pressure-sensitive silicone adhesives that stick to almost any material, can be applied and retain useful bond strength at temperatures from —100 to 500 F. Uses include bonding silicone treated electrical insulating materials and as a temporary bond to facilitate assembly of small parts prior to mechanical installation. *No. 171*

Dow Corning 220 Fluid, a special silicone fluid for sound transducers, has sound transmission characteristics similar to those of water, a freezing point below —65 F, and a flat viscosity-temperature slope. Dielectric strength is 200 volts per mil; volume resistivity is 10^{12} ohm centimeters. *No. 172*

Dow Corning Silicone Defoamers kill foam in a variety of products and processes without risk of contamination. Effective concentration range from 0.1 to 200 parts per million. Properties and typical applications are described in a new, informative reference brochure. *No. 173*

Liquid springs and shock absorbers, subject to constant recycling, have a modern design potential in a new silicone fluid, compressible up to 12% at 20,000 psi. Recently published data sheet provides detailed property information and outlines advantages of using Dow Corning F-4029 Fluid. *No. 174*

Lightweight electrical and electronic parts with excellent heat and moisture resistance, high mechanical strength and good dielectric properties can be produced with Dow Corning 301 Molding Compound. Heat distortion temperature of molded parts is greater than 900 F; flexural strength is 12,000 psi. *No. 175*

Silicone products most widely used, are indexed by type of application, in the 1955 Reference Guide to Dow Corning Silicone Products. A brief but comprehensive 8-page summary is given of the properties and applications. With increasing effort devoted to product improvement and cost reduction, such a reference guide to this remarkably stable group of engineering materials becomes increasingly important to design, production and maintenance engineers. *No. 176*

Silicone Paints Keep Home Incinerators Looking New Through Years Of Service

Long-lasting attractiveness is vital to the continued sales success of any product made for household installation. In the case of home incinerators, this feature requires a finish that will retain its original color and high gloss for years even though combustion chamber temperatures occasionally reach 750 F. Calcinator Corporation of Bay City, Michigan, pioneer manufacturer of home incinerators, achieves this important sales advantage through the use of silicone-based paints.

Early in 1952, Calcinator designers replaced the organic gray wrinkle finish on their standard model with a metallic brown modified-silicone coating. Today, the original units still look factory-fresh and are expected to retain their new appearance through many more years of service.

Calcinator's newest model is a brilliant white, chrome-trimmed unit that makes an attractive addition to any kitchen. Because silicone based finishes "beat the heat" and stay beautiful much longer, they are helping to move the home incinerator from the basement to the housewife's elbow.

The use of silicone-based finishes has made Calcinator incinerators the only unit on the market with complete Underwriter's Approval. Calcinator uses Glidden's Nubelon-S, diluted 2 to 1 with 30005 Nubelon-S Solvent. Entire casings are 5-stage phosphate treated, sprayed and baked 20 minutes at 450 F. *No. 170*

ALLIS-CHALMERS *(Continued)*

silicone resin binders in combination with glass and mica. This combination provides the exceptional thermal endurance and moisture resistance characteristic of all silicone insulations, but it lacks the flexibility and resilience of silicone rubber.

Silco-Flex insulation is expected to change many of the motor application practices in the utility and industrial fields. In power plant induced draft fan motors, for example, the abrasive effect of atmosphere-borne cinder and fly ash will have little effect on the resilient all-silicone-rubber system. Motors in cement, ore crushing and similar installations will retain high overload capacities despite reduced ventilation resulting from dust accumulation in ventilating passages.

The all-silicone-rubber system will also bring new production and maintenance economies to industries with extreme moisture or corrosion problems. In the chemical, paper, food and similar industries, for example, applications that formerly required totally enclosed motor frames may now be supplied more efficiently and economically with Silco-Flex insulated semi-protected or open type frames.

Allis-Chalmers is already building large Silco-Flex insulated machines in the 2300 and 4000 volt class. These will be priced on the same basis as previous units constructed with resinous Class H insulation. A-C engineers also expect to extend the advantages of the all-silicone-rubber system to a wide range of high and low voltage rotating equipment. *No. 169*

Dow Corning Corporation, Dept. 8606, Midland, Michigan

Please send me: 169 170 171 172 173 174 175 176

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SILICONE NEWS is published for product design and development engineers by

DOW CORNING CORPORATION
MIDLAND MICHIGAN

first in silicones
DOW CORNING SILICONES

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TORRINGTON HEAVY DUTY NEEDLE BEARINGS *are used in a wide variety of machinery, including cranes, oil field equipment, hydraulic pumps, air compressors and machine tools.*

TORRINGTON Heavy Duty Needle Bearings

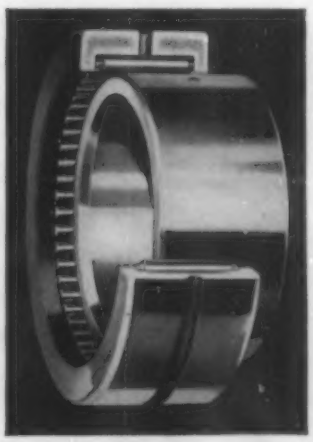
are designed and manufactured to give added strength—for long economical service

Even a casual look at the TORRINGTON HEAVY DUTY NEEDLE BEARING suggests strength—the one-piece channel construction, the sturdy roller ends and integral side flanges.

Carburizing-grade nickel steel is used for both inner and outer race, giving a harder, more wear-resistant surface, and a tougher, shock-absorbing core.

Accurately ground raceway and side flanges eliminate drag at roller contact and keep rollers in a true path.

These are some of the reasons why TORRINGTON HEAVY DUTY NEEDLE BEARINGS have earned the confidence of leading machinery builders and users in many industries. Specify these rugged TORRINGTON bearings and get top performance, low maintenance service in your equipment. They are available from stock in a complete range of sizes.



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TORRINGTON HEAVY DUTY NEEDLE **BEARINGS**

Spherical Roller • Tapered Roller • Cylindrical Roller • Needle • Ball • Needle Rollers

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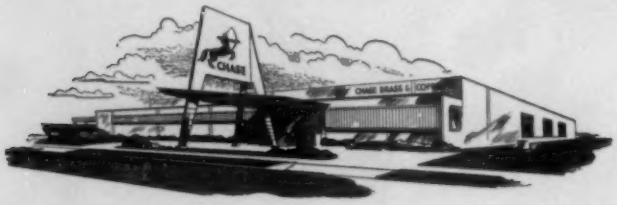
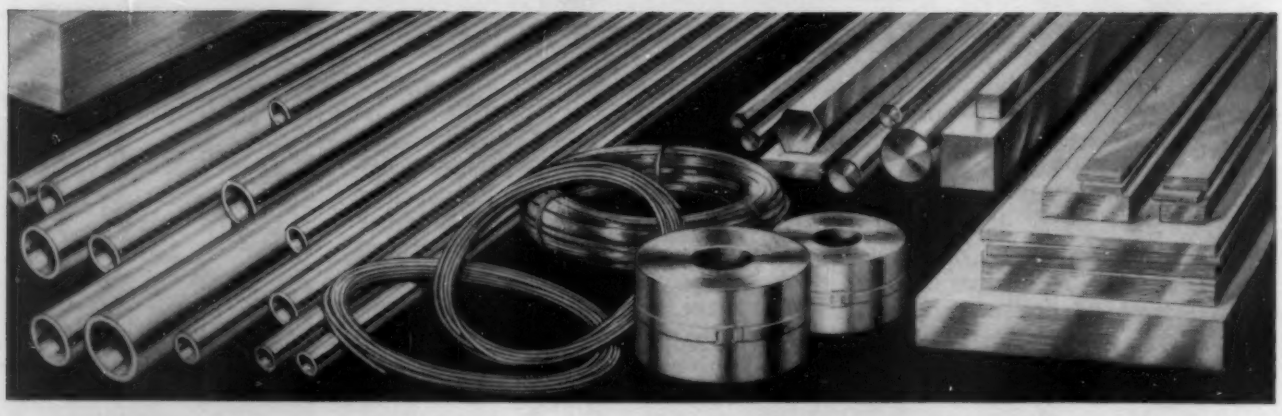


PLACE

Illustrated above: **Just three of the 25 efficient Chase warehouses dotting the nation.**

FOR STAINLESS STEEL!



Chase®

BRASS & COPPER CO.

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The Nation's Headquarters for Brass & Copper

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Charlotte†	Denver	Kansas City, Mo.	New Orleans	Rochester†	(†sales office only)

DOWEL PINS

HOW TO USE THEM

1. Precision Dowel Pins are principally used where parts must be accurately positioned and held in absolute relation to one another whether stationary or in motion. They facilitate quick disassembly and completely accurate re-assembly.

2. Allen Dowel Pins are also used as plug gauges.

3. As plugs for determining angular dimensions of dovetail slides.

4. As hinge and wrist pins in applications requiring initial and permanent accuracy.

5. As accurate, economical roller bearings and axles.

6. As guide pins, stops and position locators.

HOW TO JUDGE THEM

1. *On precision, for low tolerance applications.* (Allen Dowel Pins are ground to a maximum microinch finish of 6 RMS protected by a rust preventive.)

2. *On strength, for shear resistance.* (Allen Dowel Pins are made from special Allenoy Steel, heat treated. Single shear strength measures from 160,000 to 180,000 psi.)

3. *On hardness of surface and a core hard enough to prevent "mushrooming" when driven into a tight hole.* (Allen Dowel Pins have a surface hardness of 62-64 Rockwell C Scale and core hardness of 52-54. Average case depth .010 to .020 depending on size.)

The simple sure way to be sure of uniformly superior dowel pin quality is the same as in buying precision socket screws — *get genuine Allens from your Industrial Distributor.* Only he sells them but *we will welcome your direct request for literature or application engineering assistance.*

ALLEN HEAD

ALLEN

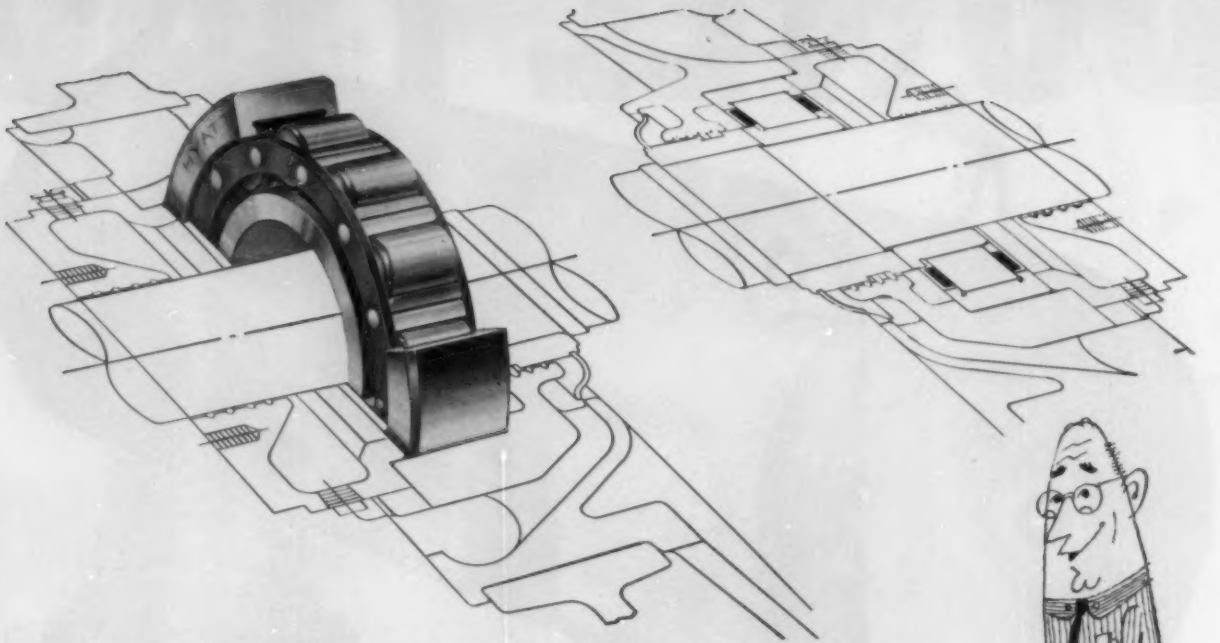
MANUFACTURING COMPANY

Hartford 2, Connecticut U.S.A.

Available in 108 Standard Sizes from ⅛" x ⅜" to 1" x 6". Standard tolerance .0002 oversize. Most sizes also standard in .001 oversize for repair work.

How Hy-Loads can help you . . .

OVERCOME OVERLOADING



HY POTENUSE, the sage of the slide rule, says:

This HYATT Hy-Load is heading for a long hard life. It's been designed into as tough a job as you can hand any bearing—the armature shaft of a steel mill motor.

These HYATT Bearings must maintain the armature on centers with very close running clearance despite the fact that *steel mill motors are frequently overloaded and are regularly reversed under full load!*

But ability to "take it" isn't the only reason leading motor builders mount HYATTS on both ends of armature shafts: the offset of the flanged inner race provides vital *inbuilt, non-adjustable free end float*, permitting the armature to center itself electrically. What's more, HYATT'S *separable and interchangeable* races facilitate quick replacement of armatures.

See why so many smart designers agree? *You can't go awry when you specify—*

YOUR COMPLETE LINE
OF CYLINDRICAL ROLLER BEARINGS

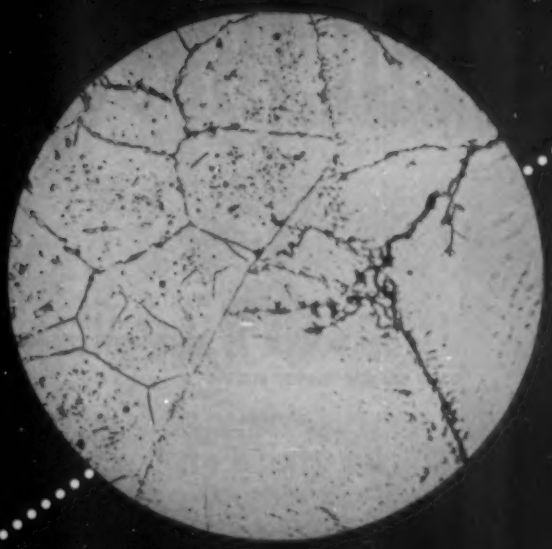
HYATT

ROLLER BEARINGS

STRAIGHT BARREL TAPER

HYATT BEARINGS DIVISION • GENERAL MOTORS CORPORATION • HARRISON, NEW JERSEY

Here's a better solution to a tough Corrosion Problem



Carpenter 7Mo Stainless Tubing & Pipe

The corrosion-inviting cracks in the right-hand section of the photomicrograph above end abruptly as they near the center of the picture... and that quick ending may help you find a quick ending to stress corrosion cracking problems.

The picture is Carpenter 7Mo stainless pipe (left) welded to a Type 316 fitting. It is still unaffected by the stress corrosion cracking that has destroyed the usefulness of the fitting. The pipe outlasted three such fittings before the photomicrograph was made.

The stout resistance of Carpenter 7Mo to stress corrosion cracking, even in the presence of chlorides or other caustic and sulphite solutions, is coupled with excellent resistance to general corrosion and pitting. It has been used as a "problem solver" in food and chemical processing plants, pulp mills, petroleum refineries and other places. There may be a profitable place for it in your operation. We'll be glad to work with you, aid you in investigation of your problems and a possible 7Mo solution.

MEMBER

The Carpenter Steel Company, Alloy Tube Division, Union, N. J.

Export Dept.: The Carpenter Steel Co., Port Washington, N. Y.—"CARSTEELCO"

Write for your copy of the Carpenter 7Mo Technical Bulletin containing comprehensive data.

Carpenter

Stainless Tubing & Pipe

only SOUTHCO® drive rivets offer all these benefits!

Rivet and Mfg. Patented.

A HAMMER IS THE ONLY TOOL

DRIVE LIKE NAILS

AUTOMATIC "PULL-UP" ACTION FORCES PARTS TOGETHER

Note

No special tools to buy or maintain, no bucking up, no finishing, no noise, no material waste.

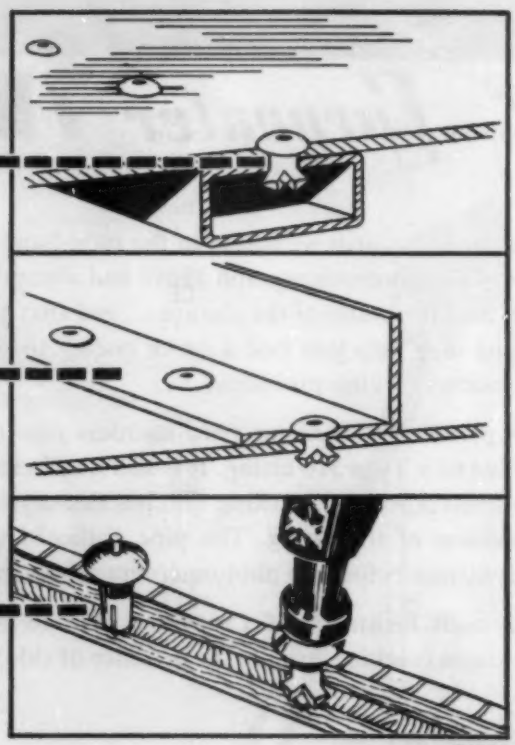
Just hit the pin, the rivet's in . . . that's all.

On your production line, where can savings be made with Southco Drive Rivets? Write for complete data. Southco Division, South Chester Corporation, 236 Industrial Highway, Lester, Pa.

FOR BLIND APPLICATIONS

FOR ACCESS APPLICATIONS

FOR METAL-TO-WOOD APPLICATIONS



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SPEED ASSEMBLY . . . CUT COSTS

SOUTHCO®

FASTENERS

PAWL • SCREW AND SPRING • DRIVE RIVETS • ANCHOR NUTS • ENGINEERED SPECIALTIES

OFFICES IN PRINCIPAL CITIES

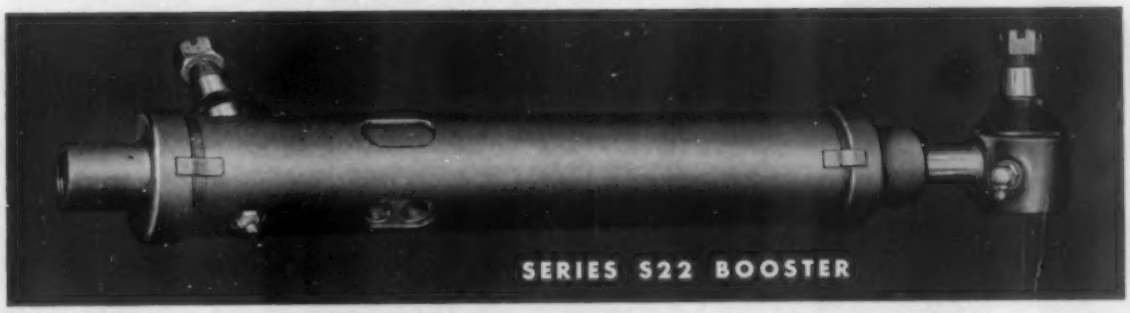
WHEREVER TWO OR MORE PARTS ARE FASTENED TOGETHER, STANDARD AND SPECIAL DESIGNS FOR IMPROVED PERFORMANCE AND LOWER PRODUCTION COSTS

EXTRA **Mobile Equipment News** EXTRA

VOL.2 — VICKERS INCORPORATED, DETROIT, MICHIGAN — NO.6

NEW—For Smaller Vehicles

VICKERS® HYDRAULIC POWER STEERING



LOW COST
Vickers Series S22 is a new, streamlined steering booster built especially for smaller vehicles. The design permits high production economies . . . and these economies are passed on to vehicle manufacturers.

SUPERIOR PERFORMANCE
The Series S22 has excellent operating characteristics . . . providing smooth, easy, fingertouch steering under all conditions. Obstructions, chuck holes, blown tires, etc. cannot spin the steering wheel or jerk it out of control on vehicles equipped with this Booster. Safer in traffic . . . on the farm . . . in the plant.

SIMPLIFIED DESIGN
Servo valve is simplified and smaller. Ease of servicing is another advantage.

EASY INSTALLATION
Oil connections can be placed in any one of four positions (90° apart) with respect to ball stud. This and the compact design make installation exceptionally easy and reduce its cost.

NEEDS LESS SPACE
Design is unusually compact and streamlined. Series S22 will go into a minimum space and usually requires little or no linkage change.

DEPENDABLE
All the "know-how" acquired in Vickers more than 25 years experience with hydraulic power steering has gone into the design and manufacture of the Series S22. Vickers hydraulic equipment of all kinds has a remarkable record of dependability. This booster is no exception.

ASK FOR NEW BULLETIN
A new bulletin gives more information on the Series S22 together with appropriate Vickers Pumps and typical circuit diagrams. Send for Bulletin M-5107.

For heavier steering applications and longer piston strokes, use Vickers Booster Series S23 (see Bulletin M-5106) or Model S6-315 (see Catalog No. M-5101).

VICKERS Incorporated
DIVISION OF THE SPERRY CORPORATION
1454 OAKMAN BLVD. • DETROIT 32, MICH.

Application Engineering Offices: ATLANTA • CHICAGO AREA (Brookfield) CINCINNATI • CLEVELAND • DETROIT • HOUSTON • LOS ANGELES AREA (El Segundo) • MINNEAPOLIS • NEW YORK AREA (Summit, N.J.) PHILADELPHIA AREA (Media) • PITTSBURGH AREA (Mt. Lebanon) ROCHESTER • ROCKFORD • SAN FRANCISCO AREA (Berkeley) SEATTLE • ST. LOUIS • TULSA • WASHINGTON • WORCESTER

VICKERS® SERIES VT16 VANE TYPE PUMP

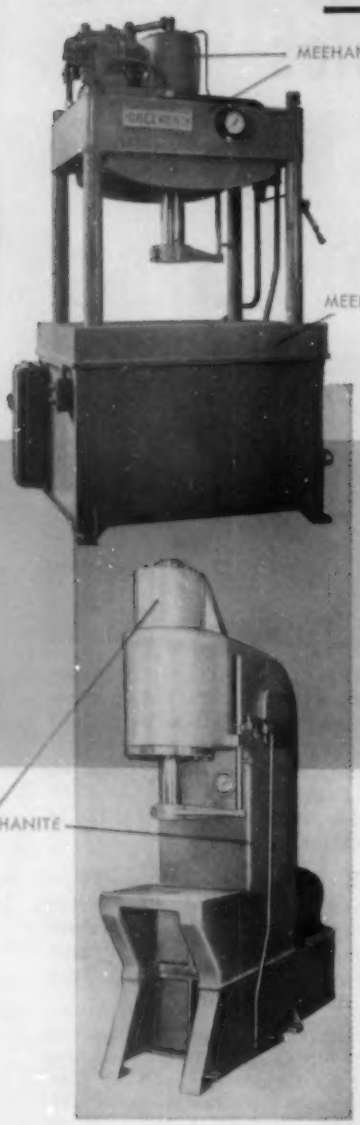
This is the pump normally used with the Series S22 Booster. It has integral volume control and relief valve, and oil reservoir. The vane type design delivers more oil with less power. Automatic wear compensation and hydraulic balance contribute to much longer life with minimum maintenance. No-load starting is another advantage in cold weather.

7179

ENGINEERS AND BUILDERS OF OIL HYDRAULIC EQUIPMENT SINCE 1921

The MEEHANITE® Casting Reporter

ALL GREENERD PRESS CYLINDERS ARE MEEHANITE METAL



The Greenerd Arbor Press Company, Nashua, New Hampshire, specifies Meehanite metal for many of their important component parts and *all* of their Press cylinders.

These cylinders are cast of Meehanite Type GA (50,000 psi) as well as the top and bottom caps of Presses under 30 tons capacity. The 30-ton Hydraulic Press is of box-type construction and cast of tough, dense Meehanite metal which reduces the vibration to a minimum. The Meehanite cylinder is a separate unit, bored and honed to size.

The 75-ton, four-posted type Hydraulic Press is a rugged machine designed for all-around maintenance and production work. The head and table are also Meehanite castings providing high tensile strength which insures rigidity and uniformity; and, of course, the cylinder is also cast of Meehanite metal.

THE MANUFACTURER SAYS:

"All our cylinders today are Meehanite castings as well as the top and bottom caps of Presses under 30 tons capacity. We also used Meehanite castings for the main frame of our 30-ton Press and on the 75-ton Press, the head and work table are cast of Meehanite metal. Meehanite castings are used for all these parts because we are particularly interested in securing strong, extremely close grain and pressure tight castings."

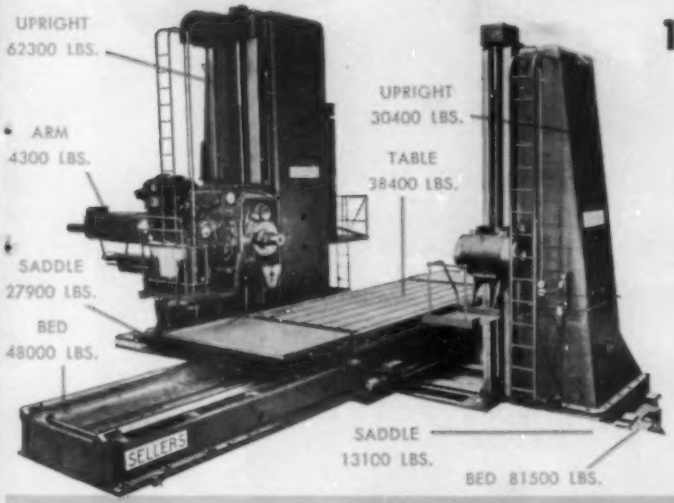
MEEHANITE METAL SPECIFIED FOR PRECISION-MACHINED SURFACE PLATES

The Goodman Manufacturing Company of Chicago, Illinois, has for years been making surface plates, one of the absolute necessities for answering the present-day requirement for greater precision in machine tool work.

THE MANUFACTURER SAYS:

"Our customers frequently specify the use of Meehanite castings for surface plates because Meehanite metal definitely provides the very fine grain structure and reduced deflection on the surface of a given surface plate for a given load, because of the superior physical characteristics of the material."

Industries report what Meehanite Castings have done for them



154 TONS OF MEEHANITE CASTINGS IN FARREL-BIRMINGHAM'S BIG SELLERS HORIZONTAL

A new Sellers, 8-inch, planer-type, horizontal boring, drilling and milling machine, built by Consolidated Machine Tool Company, Rochester, New York, has been installed in the Ansonia, Connecticut, plant of Farrel-Birmingham Company, Inc.

Meehanite castings from 27 different patterns were produced for this huge horizontal, ranging from a few pounds to 40½ tons. The more than 154 tons of Meehanite metal probably make over 90 per cent of the entire weight of this machine.

THE MANUFACTURER SAYS:

"We have long recognized the value of Meehanite metal's soundness and guaranteed physical properties to meet specific requirements. In this Sellers horizontal, for example, the heavy proportioning of the uprights and the superior vibration-damping qualities of Meehanite metal combine to practically eliminate deflection. The 96-inch x 204-inch table is likewise factored to resist sag under loads up to a maximum of 70 tons, thus permitting machining operations within extremely close tolerances.

In this case, as in thousands of other heavy machines and machine tools built with Meehanite castings under exacting controls from materials procurement to finished product, a highly satisfactory answer to our needs is being provided by Meehanite metal."

ONLY A MEEHANITE FOUNDRY CAN MAKE MEEHANITE CASTINGS

The American Laundry Machinery Co. . Rochester, New York
Atlas Foundry Co. . . . . Detroit, Michigan
Banner Iron Works . . . . . St. Louis, Missouri
Barnett Foundry & Machine Co. Irvington and Dover, New Jersey
Blackmer Pump Company . . . Grand Rapids, Michigan
Compton Foundry . . . . . Compton, Calif.
Continental Gin Co. . . . . Birmingham, Alabama
The Cooper-Bessemer Corp. Mt. Vernon, Ohio & Grove City, Pa.
Crawford & Doherty Foundry Co. . . . Portland, Oregon
DeLaval Steam Turbine Co. . . . . Trenton, New Jersey
M. H. Detrick Co. . . . . Newark, N. J. and Peoria, Ill.
Empire Pattern & Foundry Co. . . . . Tulsa, Oklahoma
Farrel-Birmingham Co., Inc. . . . . Ansonia, Connecticut
Florence Pipe Foundry & Machine Co. . Florence, New Jersey
Fulton Foundry & Machine Co., Inc. . . . Cleveland, Ohio
General Foundry & Manufacturing Co. . . Flint, Michigan
Georgia Iron Works Co. . . . . Augusta, Ga.
Greenlee Foundry Co. . . . . Chicago, Illinois
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Johnstone Foundries, Inc. . . . . Grove City, Pennsylvania
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Lincoln Foundry Corp. . . . . Los Angeles, California
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Pohlman Foundry Co., Inc. . . . . Buffalo, New York
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Shenango-Penn Mold Co. . . . . Dover, Ohio
Sonith Industries, Inc. . . . . Indianapolis, Ind.
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Otis Elevator Co., Ltd. . . . . Hamilton, Ontario

Write for your copy of "The Handbook of Meehanite Metals"

This Advertisement Sponsored by Foundries listed above

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714 North Ave., New Rochelle, N. Y.

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If accurate flow control of hydraulic oil under varying pressure conditions is a requirement—a WATERMAN FLOW REGULATOR is the answer.

- Fixed flow regulators can be set to control from 0.1 GPM to 80 GPM.
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- Full range adjustable regulators can regulate flows from 0.5 to 20 GPM.
- For corrosive fluids, WATERMAN FLOW REGULATORS can be manufactured from brass, bronze, naval bronze, stainless steel, titanium, or any known machinable metal.

Send for these free FLOW REGULATOR BULLETINS

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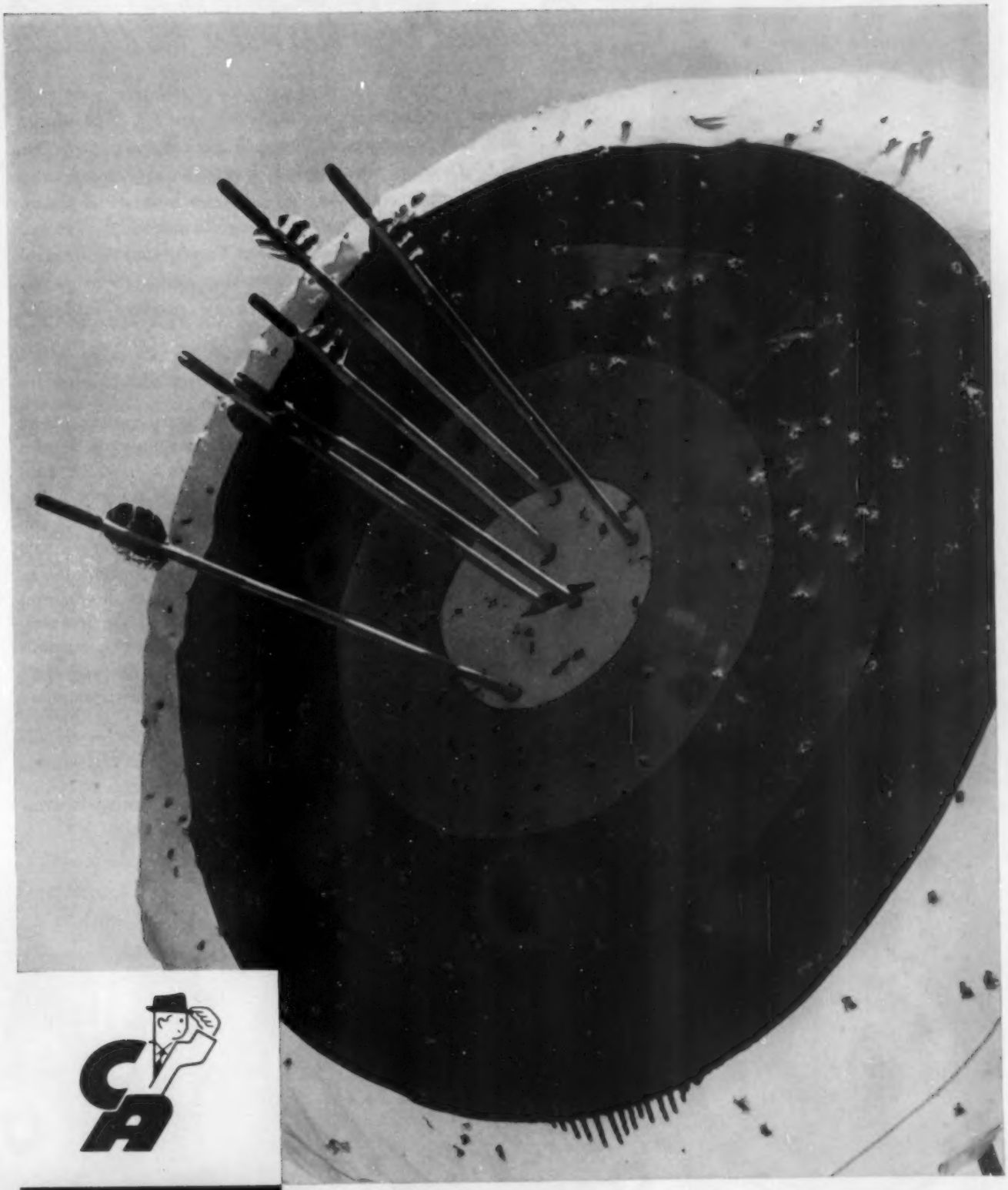


advanced know-how makes the difference...

Advanced know-how makes the difference

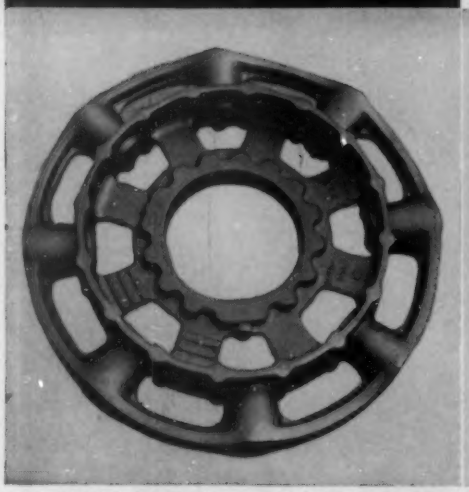
Hitting the target in any field of endeavor is the result of know-how based on experience and experiment . . . of knowledge, skill, imagination and an intangible spirit that seeks perfection. These are the things which make the difference between routine and creative handling . . . between success and failure. Here are the highlights of casting methods which show how advanced know-how at Cooper Alloy has made it possible to produce intricate stainless steel parts to quality standards formerly considered impossible.

SHELLCAST®

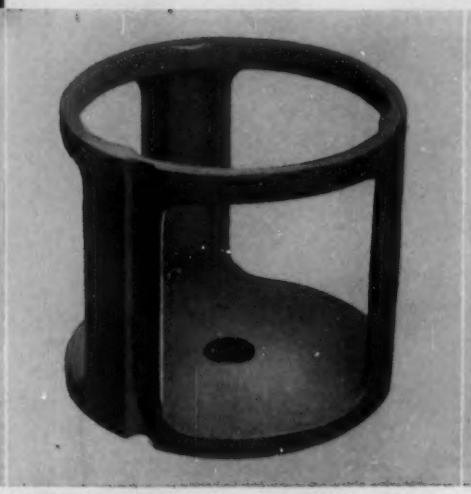
The development of methods for producing cast shapes in thin, light weight, resin-bonded shells represents a most revolutionary change in the foundryman's art. Like most inventions it was born of the necessity to produce molds faster, more economically and with greater accuracy . . . and to cast parts to closer tolerances, with superior surface finish, greater legibility of markings and better appearance, as well as with thinner sections, small cored holes, well detailed contours, minimum draft and intricate recesses. These advantages are available to design engineers and manufacturers who take advantage of our *advanced know-how* and specify—"Shell-cast by Cooper Alloy"—for their stainless steel components.

SHELLCORE

In some cases the interior surface of the casting is even



JET ENGINE SUPPORT — produced by Shellcast® method, in alloy type 18-8SMO (316)—modified. Weight 35 lbs.



INSTRUMENT HOUSING — produced by combining Shellcast® and shellcore methods, in alloy type 18-8S (302). Weight 1 lb.

JET AFTERBURNER COMPONENT—produced by core-mold method, in 12% chrome alloy (tool steel). Weight 11 lbs.

more critical than the exterior, and the core rather than the mold, becomes the big problem. The answer lies in the production of hollow cores by the most intricate methods. Specially designed metal core boxes are used in conjunction with core blowing equipment to produce hollow "shell cores" of superior accuracy and fine detail. These cores fit the mating molds much more closely than sand cores ever could. When it comes to extremes of tolerances—inside and out—Cooper Alloy *advanced know-how* with shell molds and shell cores makes the difference.

COREMOLD

For most castings, the standard sand mold is adequate, but when specifications demand extreme smoothness of surface and close matching of many components, the use of special core mold assemblies becomes necessary. Core sand can be baked hard and when used for making molds it produces an excellent mating surface for cores and assures extra smoothness to the casting surface. Coremolding is a technic widely used for aircraft parts where intricate sections have to be mated and tolerances are close. Cooper Alloy *advanced know-how* puts coremold methods at your disposal.

CENTRIFUGAL CASTING

Casting centrifugally is a procedure offering very specific advantages, including the ability to cast very thin, light weight airfoil sections. The spinning action promotes favorable directional solidification and helps purge castings of impurities. Whether made in metal molds or in sand, castings by the centrifugal method meet highest quality standards, particularly when backed up with the Cooper Alloy *advanced know-how* which has grown out of an unsurpassed intimacy with the process ever since its inception.

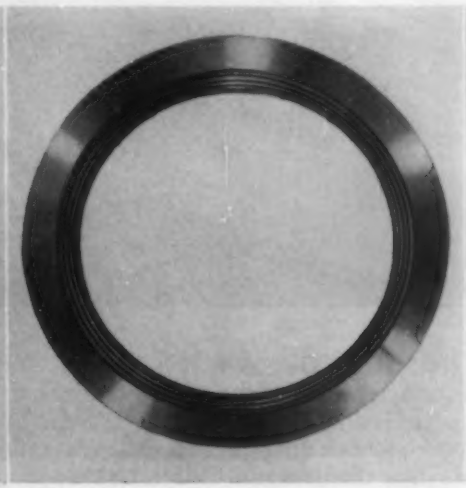
SAND CASTING

The heart of the foundry industry still lies in the production of quality castings in sand molds. But so important is the engineering, the patternmaking, the heading and gating, melting, molding, pouring, heat treatment, pickling . . . so critical is the use and application of x-ray, zyglo, gamma ray, pressure testing . . . so variable are the multiple of control items involved in the pouring of almost thirty different high alloys . . . that even in the production of castings by "conventional methods" quality depends on experience. Here too, Cooper Alloy leadership is your guarantee of the *advanced know-how* that makes the difference.

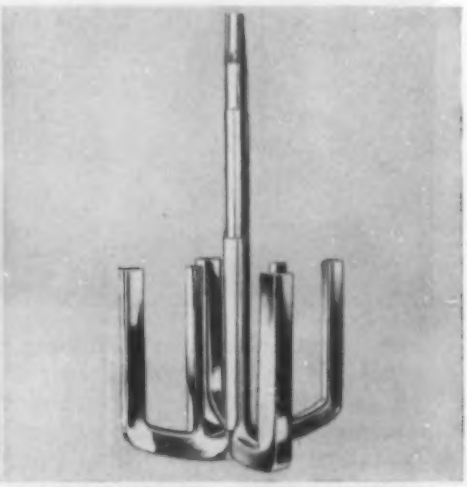
Tomorrow is ever with us . . .

Our search for new and better ways to produce quality stainless steel castings more economically, for new materials to resist corrosion or abrasion, for new products to answer the needs of the process and metalworking industries . . . goes on continually. Research links us with tomorrow and assures you of the best in thinking, the best in technology. Cooper Alloy *advanced know-how* can make the big difference in your product. Your inquiries are invited.

SUPERCHARGER DIAPHRAGM — produced by centrifugal casting method using coremolds, in alloy type 25-20 (310). Weight 25 lbs.

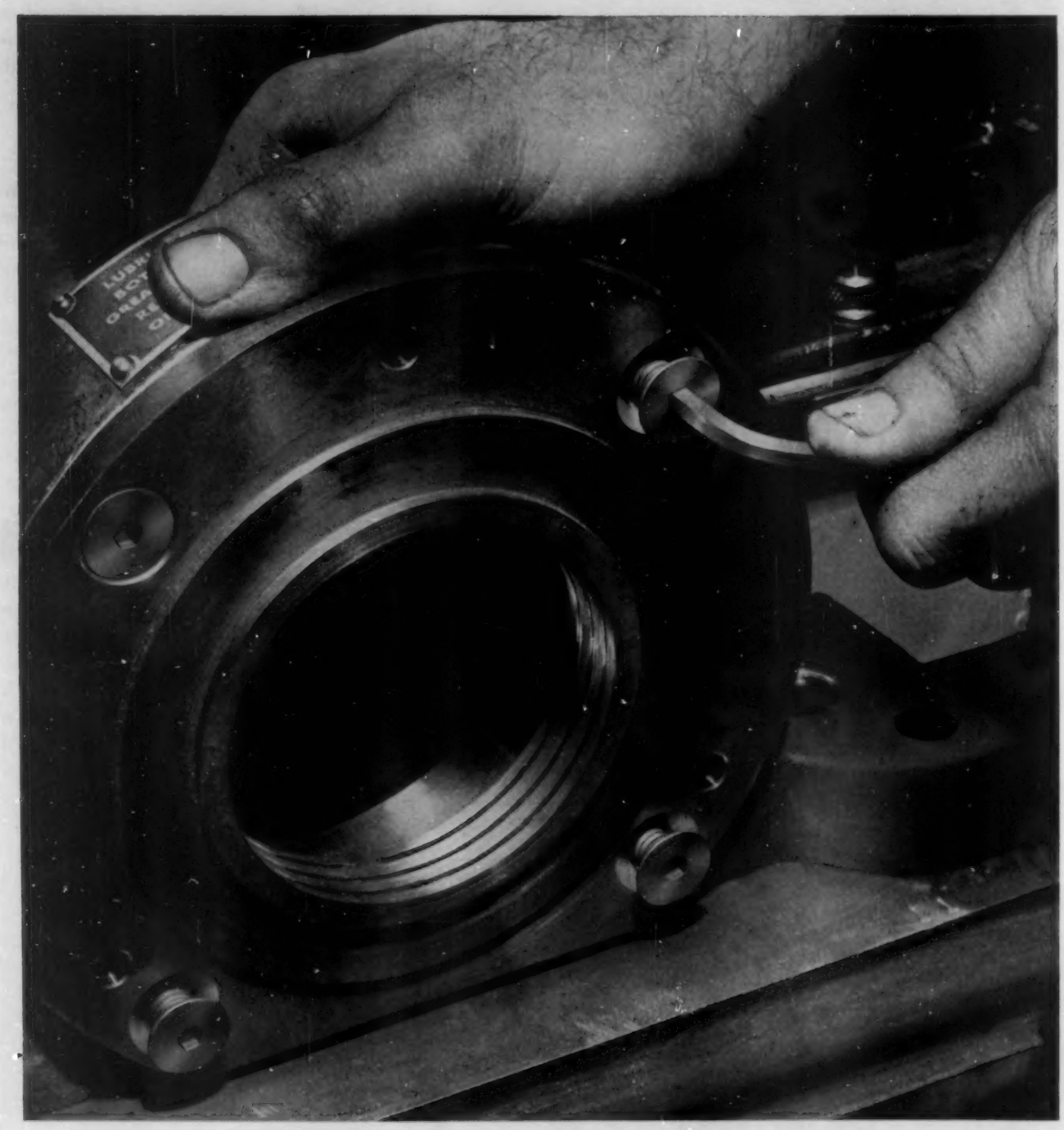


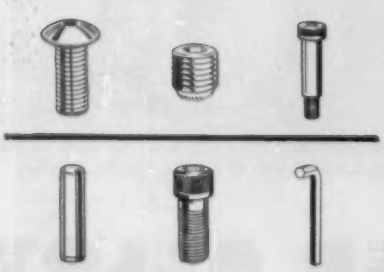
JET ENGINE RING—produced by centrifugal method using permanent metal molds, in alloy type 23-12W.



CHEMICAL AGITATOR — produced by sand casting method, in alloy type 18-8S (302). Weight 2500 lbs.

COOPER ALLOY
CORPORATION • HILLSIDE, N.J.
Foundry Products Division





FINISHING OFF WITH UNBRAKO FLAT HEADS. Holding a thin-section assembly together, and finishing it off with a smooth, good-looking surface is a job for UNBRAKO Flat Head Socket Cap Screws. These precision socket screws are designed for such applications. Heat treated alloy steel provides the strength. Uniform 82° angle under the head assures maximum contact. Accurate hex sockets prevent marring of the screw head or assembly surface. And these UNBRAKOS are easy to get—they are stocked by authorized industrial distributors everywhere. STANDARD PRESSED STEEL CO., Jenkintown 28, Pa.

UNBRAKO® SOCKET SCREW DIVISION sps JENKINTOWN, PENNSYLVANIA

What is your Control Need?

. . . a starter for a fractional hp motor?

This small inexpensive control provides thermal overload protection. . . . Compact construction permits mounting where space is at a premium. Designed for use on ac single-phase power systems . . . up to 230 volts.

. . . a controller for a 2300 to 5000-volt motor?

Here is a control for motors up to 2500 horsepower. All components — contactors, meters, overload relays, auxiliary switches — are selected to meet the particular requirements of your application. Current-limiting fuses give split cycle short circuit protection.

. . . or other applications?

Specific applications, including those between the above-mentioned limits, are made from an extensive line of starters and control components. These standard units are factory assembled in infinite combinations to meet practically any requirement. For help on a particular application, call your Allis-Chalmers representative. His recommendations are backed by Allis-Chalmers engineering departments . . . by experience gained solving thousands of control problems . . . by complete research and testing facilities.

A-4721

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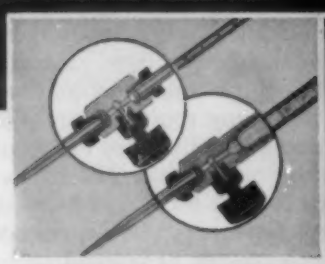
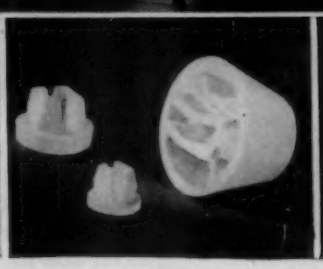
Milwaukee 1, Wisconsin

Self-lubricating and TEFLON® offer important

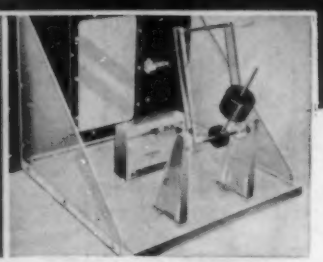


TEFLON® tetrafluoroethylene resin is especially suited for use under severe service conditions. No chemicals normally found in industry attack it. "Teflon" can be used where service temperatures reach 500° F. Outstanding dielectric properties make "Teflon" ideal for electronic applications. These needle valve buret parts of "Teflon" permit fine measurements.



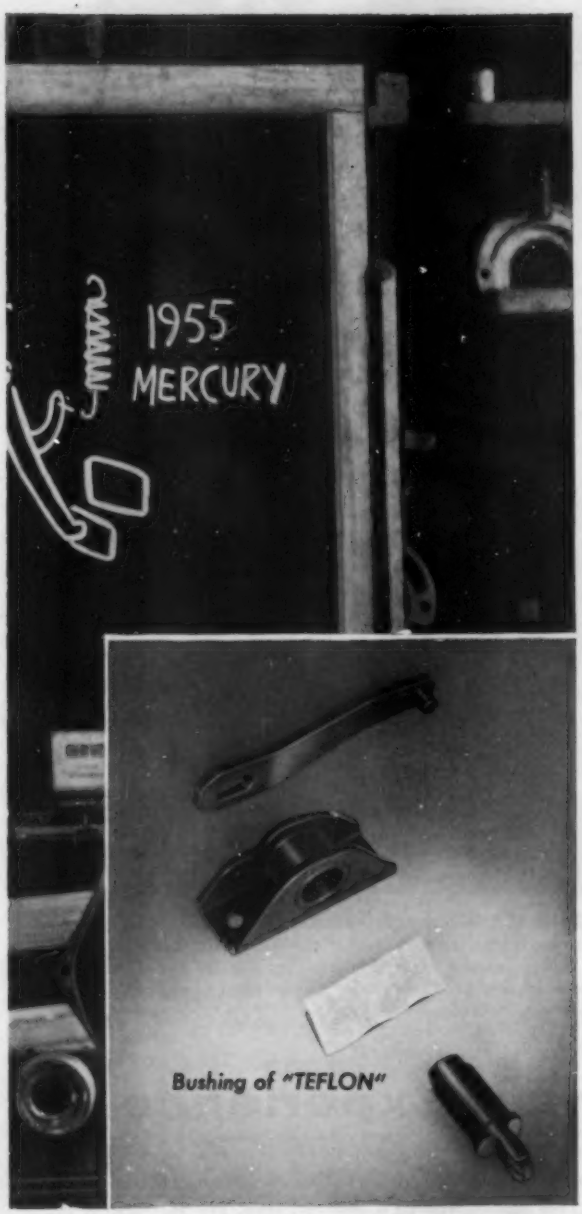
ZYTEL® nylon resin is a versatile Du Pont engineering material for mechanical applications. Parts made of it are strong, resilient, and lightweight. Often they require no lubrication. "Zytel" can be economically mass-produced by injection molding. Here are several types of self-retaining, non-conductive grommets molded of Du Pont "Zytel" nylon resin.

ALATHON® polyethylene resin has good chemical resistance and excellent dielectric properties. "Alathon" is tough and flexible over a wide range of temperatures. Freedom from odor, taste, and toxicity makes it an ideal packaging material. Shown is a flexible pouring spout of "Alathon" polyethylene resin that fits on paint cans for easier pouring.



LUCITE® acrylic resin is used to make products that are both functional and decorative. The most beautiful of all engineering materials—it is produced clear and in color. Products of "Lucite" are shatter-resistant, have good dimensional stability and possess excellent resistance to weathering. Here is a voltage tester made almost completely of "Lucite."

heat-resistant properties of advantages in product design



This new 0.014"-thick self-lubricating bushing of Du Pont "Teflon" tetrafluoroethylene resin is now in the clutch lever assembly of the 1955 Mercury. The bushing of "Teflon" outwore bronze in a test conducted by Lincoln-Mercury engineers. Moreover, it reduces unit cost. "Teflon" supplied by Raybestos-Manhattan, Inc., Manheim, Pennsylvania.

DU PONT

REG. U.S. PAT. OFF.

BETTER THINGS FOR BETTER LIVING
... THROUGH CHEMISTRY

Clutch lever bushing of "TEFLON" needs no grease fitting—simplifies assembly, reduces unit cost

Two factors made it necessary to develop a clutch lever assembly bushing needing no lubrication on the 1955 Mercury. Because this bushing is located near the exhaust pipe, heat might have thinned out the lubricant. In addition, all possible locations for the grease fitting were so difficult to reach that lubrication would have been almost impossible.

Lincoln-Mercury set out to develop such a bushing. One of the materials they tested was a wrap-around bushing of Du Pont "Teflon" tetrafluoroethylene resin (see cut). This .014"-thick bushing was run through a grueling 300,000-cycle test—subjected to dust and water along the way.

Better performance at less cost. Test results were impressive. They showed that the bushing of "Teflon" withstands wear far better than the bronze bearing originally considered for the clutch lever assembly. "Teflon" is impervious to chemical attack, won't absorb moisture and is heat-resistant to 500° F. Its low coefficient of friction (comparable to ice against ice) and self-lubricating properties make oiling unnecessary. With this new bushing, Lincoln-Mercury reduces unit cost by eliminating the grease fitting and several assembly steps.

Have you investigated the unique properties of Du Pont "Teflon" tetrafluoroethylene resin and the other members of the Du Pont family of engineering materials—"Zytel" nylon resin, "Alathon" polyethylene resin and "Lucite" acrylic resin? The applications shown here are typical product improvements—possible when design and service requirements are evaluated in terms of the properties of these versatile engineering materials. For further information on their properties and uses, clip the coupon below or write to E. I. du Pont de Nemours & Co. (Inc.), Polychemicals Dept., Room 106-2, Du Pont Building, Wilmington 98, Delaware.

E. I. du Pont de Nemours & Co. (Inc.), Polychemicals Department
Room 106-2, Du Pont Building, Wilmington 98, Delaware
In Canada: Du Pont Company of Canada Limited, P.O. Box 660, Montreal, Quebec

Please send me more information on the Du Pont engineering materials checked: "Zytel" nylon resin ☐; "Alathon" polyethylene resin ☐; "Lucite" acrylic resin ☐; "Teflon" tetrafluoroethylene resin ☐. I am interested in evaluating these materials for _____

_____

Name _____

Position _____

Firm Name _____

Type of Business _____

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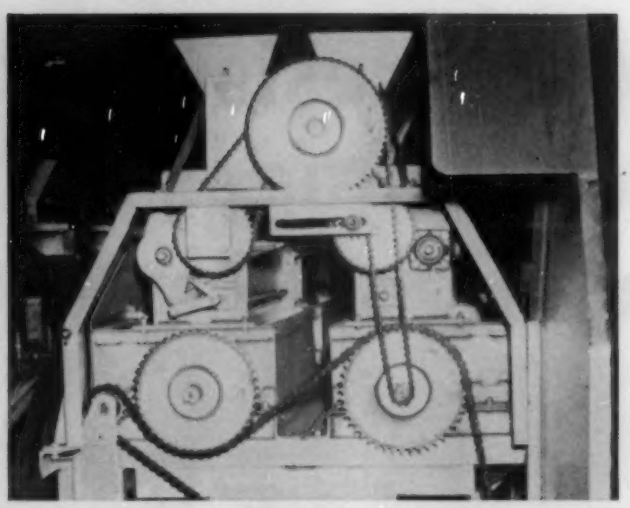
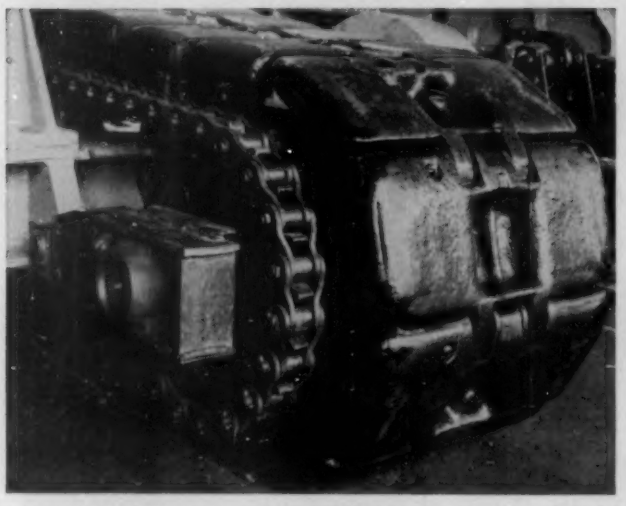
City _____

State _____

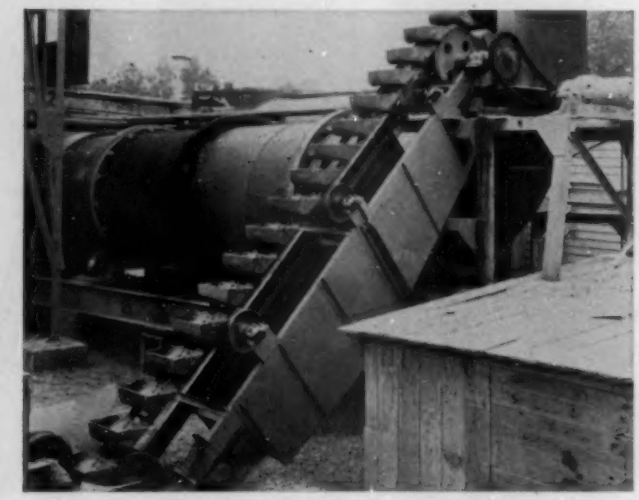
SMOOTH CONVEYING AND LONG LIFE were required in this conveyor carrying auto headlights through an oven. The CHAIN Belt Man had the right answer...Rex® Double Pitch Roller Chains with carrier rollers...low in cost but high in service . . . saves space and power costs.



CUTTING COST, SPACE AND WEIGHT resulted from the application of Rex Roller Chain on this bean separator by the CHAIN Belt Man. From a single power source, the chains drive a number of shafts insuring accurate timing, eliminating heavy gear trains and shafting.



TOUGH SERVICE such as the crawler drive on a power shovel is a natural for Rex Chabelco Steel Chains. These rugged chains with their built-in clearances between working parts operate effectively in conditions of dust, dirt and heavy shock loads . . . assures more years of service.



FOUR TIMES THE SERVICE resulted from the Chain Belt Man's chain recommendation on this bucket elevator. Rex Z-Metal Chains are going strong after 4 years' service in abrasive operating conditions. Ordinary cast chain used previously gave only one year service.

You Can Profit By Their Chain Experience

If you have a design problem involving chain drives or conveyors, why not profit by the experience of others? Consult your CHAIN Belt Field Sales Engineer. In case after case this experienced chain application engineer has solved problems of reducing costs . . . improving performance...saving space.

Your CHAIN Belt Man has a *complete* line of chains to choose from...can select and apply the one best choice for your needs. He knows no limitations in his selections...no handicaps of a limited line. He studies the operating conditions...the loads, speeds, mechanical requirements and your needs. And, then he arrives at the right answer.

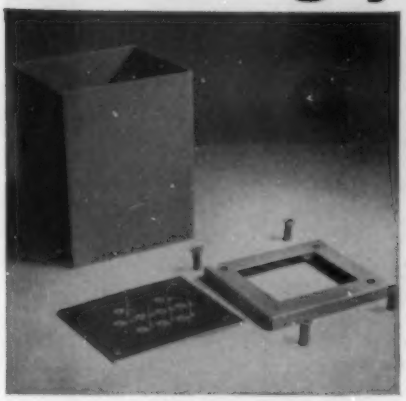
Why not put his experience to work for you? Call your CHAIN Belt Man or write CHAIN Belt Company, 4715 W. Greenfield Ave., Milwaukee 1, Wis.

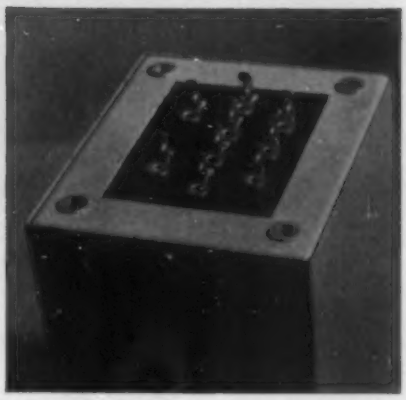
AT YOUR SERVICE
to help you with chain drive and conveying applications
YOUR CHAIN Belt Man

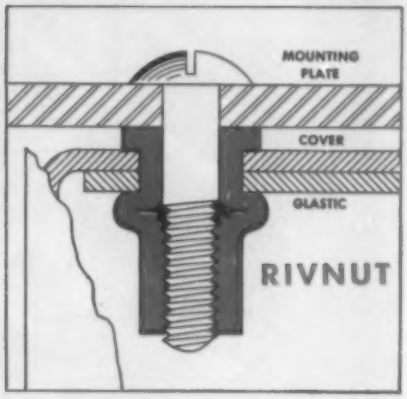
CHAIN BELT COMPANY

District Sales Offices in all principal cities

One B. F. Goodrich Rivnut does two fastening jobs to save time, money







In transformer assembly, Rivnuts fasten glastic to metal cover; also serve as mounting lugs.

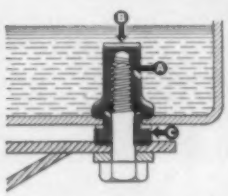
B. F. GOODRICH RIVNUTS cut costs and speed assembly because (1) they fasten materials together; (2) they provide a firm, accurate nut plate at the same time. And they do both jobs in one quick operation! Welding, tapping and clinching are eliminated. Rivnuts can be installed from one side and take an attachment bolt from either end.

The photographs at top show how B. F. Goodrich Rivnuts simplify assembly of transformers made by the SNC Mfg. Co. Starting with unassembled parts, one worker fastens the sheet of glastic to the metal cover with Rivnuts in seconds. With the cover secured to the frame, the Rivnuts then serve as mounting lugs for holding the completed transformer in place on the mounting plate.

B. F. Goodrich Rivnuts have cut costs by speeding up thousands of fastening jobs. Whatever your fastening problem, they can probably do the same for you. Get more information or engineering help by writing: The B. F. Goodrich Company, Dept. PE-65, Akron, Ohio.

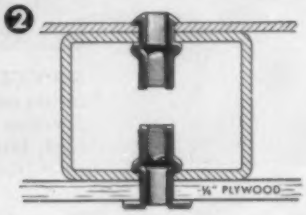
If you have fastening jobs like these, get B. F. Goodrich RIVNUTS

❶



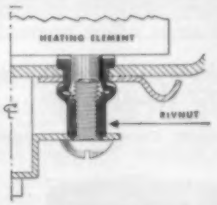
ELIMINATES BRAZING! Rivnuts with closed end (B) are installed in one-tenth the time it took to braze nut plates on oil reservoir tanks. Leaking, warping and thread cleaning are eliminated (A). Spacer head (C) positions tank.

❷



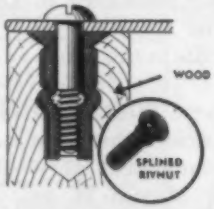
FASTENS PLYWOOD TO STEEL! Easier to install than wood or self-tapping screws, Rivnuts fasten plywood walls to tubular steel sections in trailers. No wood filler needed.

❸



ELIMINATES REINFORCING PLATE! In assembly of vaporizers, Rivnuts do away with reinforcing plate, don't turn under torque, hold flange securely without bending. Result: less assembly time, fewer parts, better product.

❹



GIVES 6 CLEAN THREADS IN WOOD! Special Rivnut for solid fastening in wood eliminates wood screws, provides 6 metal threads for attachment bolt. Bulge formed by upsetting holds Rivnut fast. Splined shaft keeps it from turning.

SEND NOW FOR FREE RIVNUT DEMONSTRATOR

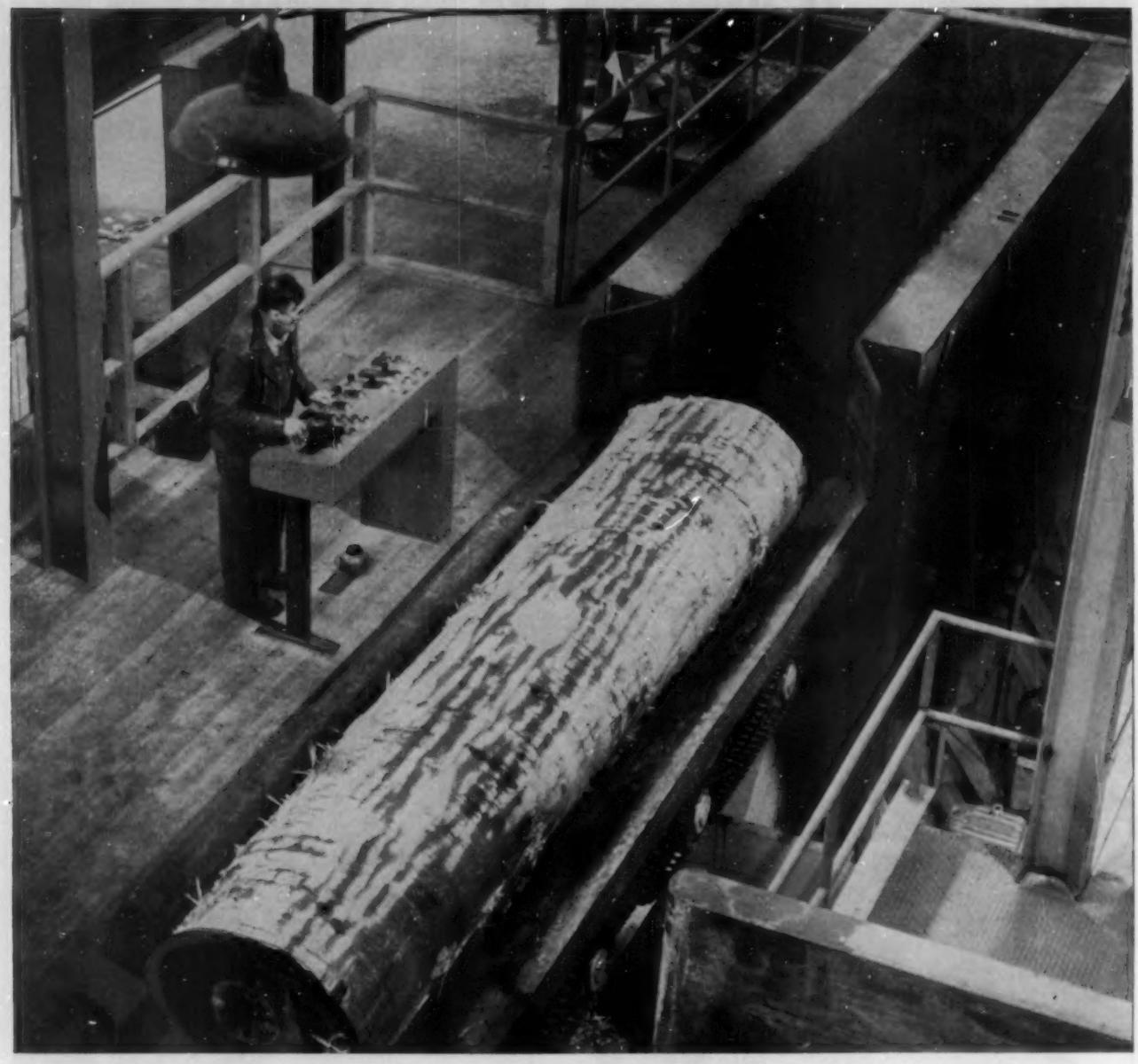
Demonstrates with motion how you can use Rivnuts to fasten TO and fasten WITH. Explains construction, simplicity of installation. Get your free copy today by writing to: The B. F. Goodrich Company, Department PE-65, Akron, Ohio.

B.F.Goodrich

RIVNUT

The only one-piece blind rivet with threads

Mayari R makes it lighter... stronger... longer lasting



Making Chips Out of Tall Timber

Down from a Northwest tree farm the tall timber comes, to the pulp mill of Rayonier Inc., at Port Angeles, Wash. Then, barked and soaking wet, each 20-ft log is mechanically tipped into this steel chute which holds it upright while the chippers cut it up for the pulp digesters.

Measuring 9 ft around and weighing several tons, these thumping big logs pound the chute unmercifully. But Rayonier engineers foresaw this ordeal, and designed the chute with husky plates of Mayari R high-strength, low-alloy steel. Mayari R's high yield point and resistance to corrosion, impact and abrasion arm the chute for a long life in this grueling service.

Leckenby Structural Steel Company, of Seattle, fabricated the chute for Rayonier. Like many other fabricators, they found Mayari R as weldable and workable as other steels, without sharp changes from usual procedures. Our Catalog 353 gives the Mayari R story in full, including numerous case histories and application photographs. You can get a copy promptly through the Bethlehem sales office nearest you.

BETHLEHEM STEEL COMPANY
BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. *Export Distributor:* Bethlehem Steel Export Corporation

BETHLEHEM STEEL

Forms metal by new cold flowing process–TIMKEN® bearings assure wall thickness within ±.002"

FLOTURN, a radically new metal-working process developed by Lodge & Shipley, applies continuous pressure to a metal blank, forming it to the shape of a mandrel. It's an extremely accurate process. Even under heavy loads at high speeds, this L & S No. 40 FLOTURN Lathe holds wall thickness tolerances to ±.002".

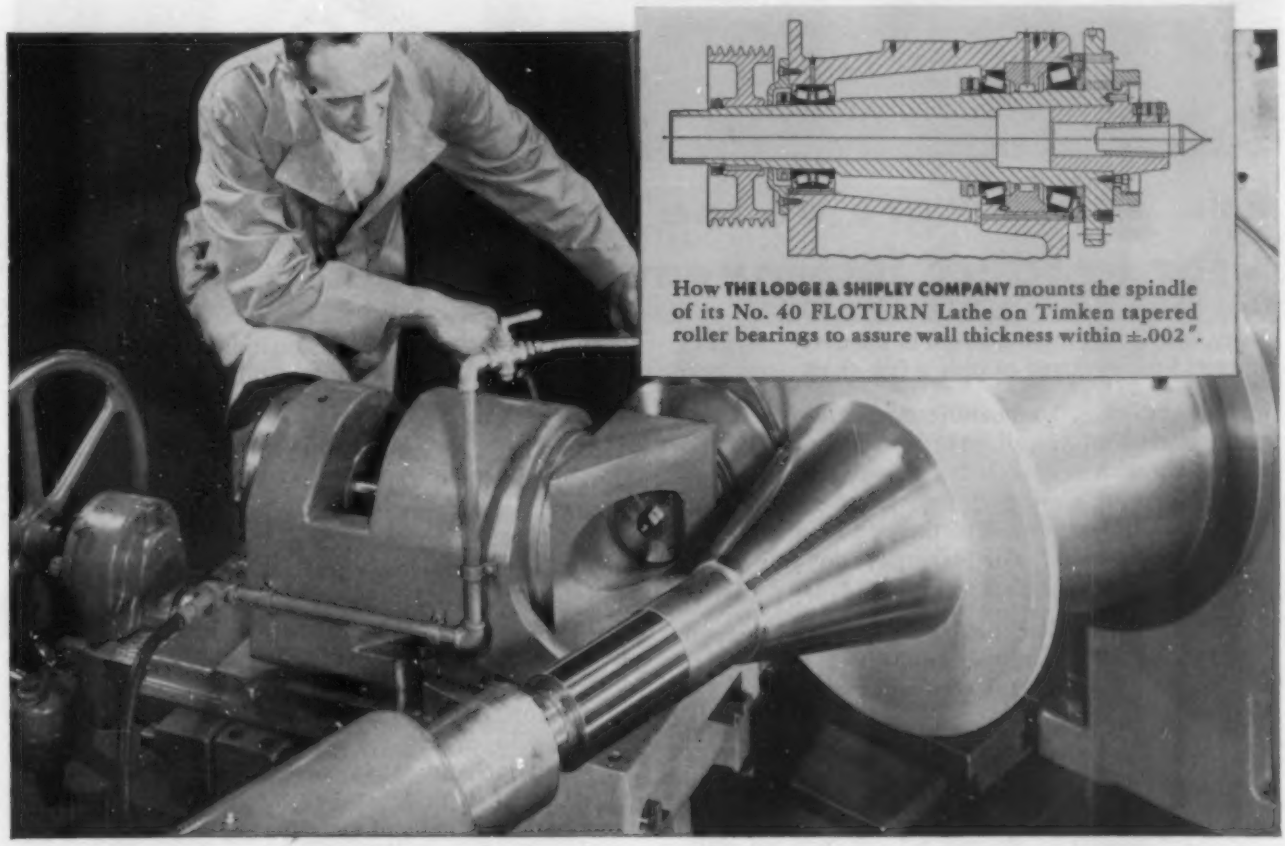
One big reason for this accuracy is the Timken® tapered roller bearings on the spindle. The tapered construction of Timken bearings lets them take the heavy radial and thrust loads in any combination—holds the spindle in rigid alignment. And line contact between the rollers and races of Timken bearings gives them extra load-carrying capacity — important since the metal is shaped by very high pressures.

Timken bearings practically eliminate friction, saving power. The geometrically correct design of Timken bearings gives them true rolling motion; their accuracy lives up to that design.

Under normal usage, Timken bearings last the life of the machine tool. One reason is that they're made of Timken fine alloy steel. We have to make the steel ourselves, because that's the only way we can completely control quality. No other U. S. bearing maker does it.

Whatever machine tool you build or buy, be sure it's equipped with Timken tapered roller bearings. Always look for the trade-mark "Timken" on every bearing. The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable address: "TIMROSCO".

This symbol on a product means its bearings are the best.



How **THE LODGE & SHIPLEY COMPANY** mounts the spindle of its No. 40 FLOTURN Lathe on Timken tapered roller bearings to assure wall thickness within ±.002".

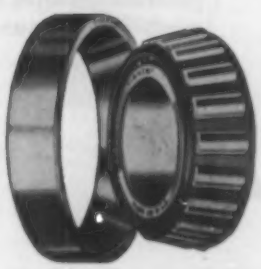
OUR OWN NICKEL-RICH ALLOY STEEL MAKES TIMKEN BEARINGS TOUGHER

Nickel makes steel tougher. And we don't skimp on nickel in the fine alloy steel we make for Timken bearings. Our steel-making specialists use the exact amount to give Timken bearings the toughness they need to withstand shock, last longer. We control the quality of Timken bearings at every step in production—from melt shop through final bearing inspection.

TIMKEN

TRADE-MARK REG. U. S. PAT. OFF.

TAPERED ROLLER BEARINGS



NOT JUST A BALL ○ NOT JUST A ROLLER ▭ THE TIMKEN TAPERED ROLLER ▭ BEARING TAKES RADIAL ◫ AND THRUST →◫← LOADS OR ANY COMBINATION

Are You Aware of the Exciting Opportunities for Product Improvement that Exist Now?

Today, industry is forging ahead in the development of products little dreamed of only a few short years ago.

Instrumentation . . . miniaturization . . . more automatic production . . . all are demanding parts and components with new operating advantages. And High Nickel Alloys are playing an important part in meeting the needs. Are *you* aware of the opportunities High Nickel Alloys offer? For example, do you know you can . . .

. . . Design smaller, lighter weight units through the use of "extremely sensitive" alloys that respond to very weak electrical currents?

. . . Assure precision product performance with the help of an alloy that exhibits infinitesimal size change through temperature ranges up to 400°F?

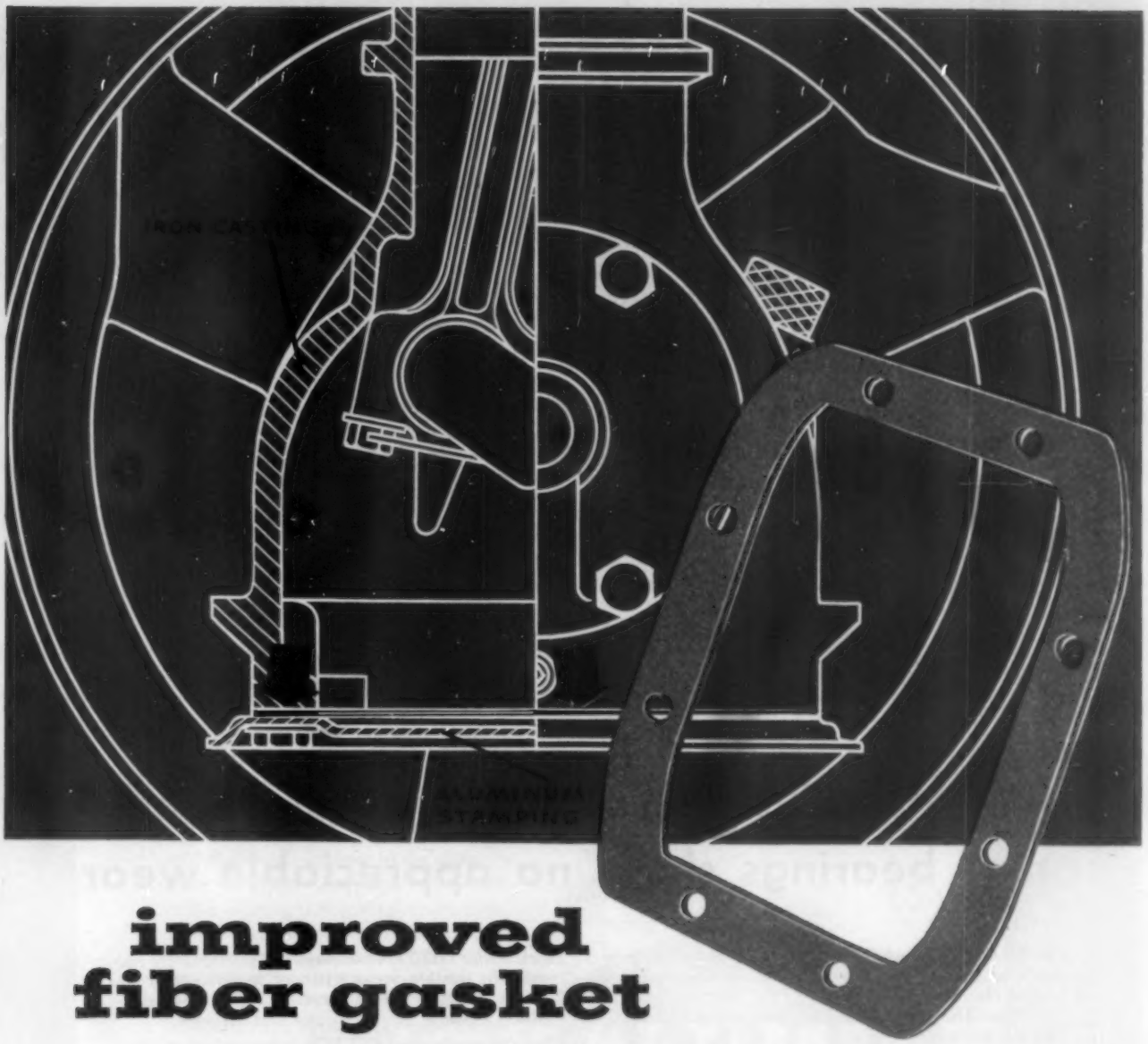
. . . Compensate a given magnetic field for temperature changes to insure consistently accurate product performance?

And the list goes on . . . an exciting list of properties that can lead to rewarding fields of new and improved products!

Getting High Nickel Alloys to do special jobs for you . . . making them behave in the way *you want them to behave* . . . is an opportunity we welcome. By making a team of your engineering experience and Carpenter's ability to produce closely controlled High Nickel Alloys with predetermined behavior, you often take an immediate step to product improvement. To help you in this job, Carpenter manufactures an unusually complete line of High Nickel Alloys . . . Temperature Compensator, Low Expansion, High Permeability and Glass Sealing Alloys. These are available in the largest variety of forms including strip, wire, bars, tubing, forging billets, etc. Ask for detailed engineering and application information. A note on your company letterhead is all that's necessary. THE CARPENTER STEEL COMPANY, 117 W. Bern St., Reading, Penna.

Carpenter STEEL — High Nickel Alloys

Pioneering in Improved Tool, Alloy and Stainless Steels Through Continuing Research
Export Department: The Carpenter Steel Co., Port Washington, N.Y.—"CARSTEELCO"



improved fiber gasket

won't dry out or shrink, stops oil leaks

Oil leakage was the subject of frequent complaints received by an air compressor manufacturer. According to reports, leaks resulted when the compressor oil pan gaskets dried out. Lubricating oil in the pans was extracting the binder from these fiber gaskets, causing them to shrink and leak.

Oil leakage was stopped when the manufacturer began using Armstrong CN-705 Accopac®. This improved fiber material is made with a non-extractable latex binder . . . it will not dry out or shrink in any recommended application. The new specification also lowered costs because Accopac's unusual compressibility permitted the use of a thinner gasket.

Many troublesome sealing problems are solved easily with materials in the Armstrong Accopac family. These materials are unique compositions of cellulose fiber, cork, and latex binder. Accopac's uniformity insures remarkable crush resistance, good recovery, and ability to seal at bolting pressures as low as 800 lbs./sq. in. Test Accopac whenever you need extra dependability in a low-cost gasket material.

FREE 24-PAGE MANUAL—Look for "Armstrong Gasket Materials" in Sweet's product design file . . . or write for your personal copy. It contains more about Accopac as well as facts about Armstrong synthetic rubber, cork composition, and cork-and-rubber. Write to Armstrong Cork Company, Industrial Division, 7006 Irvin Street, Lancaster, Pennsylvania. **And be sure to specify Armstrong Gasket Materials when you order from your gasket fabricator.**

Armstrong Accopac

. . . used wherever performance counts

ONLY CHRYSLER MAKES OILITE®

one-half million spins under tension and— OILITE bearings show no appreciable wear

Here's a fishing reel that is subjected to laboratory tests far more drastic than it receives from anglers —*and the self-lubricating OILITE bearings take it in stride.* Here's what the spinning reel manufacturer reports:

"Last summer we had one stock reel tested under tension (up to and including four pounds) at varying speeds. This reel had your bearings, of course.

"Our original intention was to give the reel a breakdown test. However, after running the reel under tension 186,727 revolutions of the crank handle, actually revolving the head over half a million times, we found that the bearings showed no appreciable wear. *In fact, your bearings appeared only slightly worn in. This is a terrific recommendation, in our opinion, for your bearings.*"

The impregnated oil in self-lubricating OILITE bearings is held in storage by capillary attraction and provides a surface film for positive, constant lubrication. OILITE bearings are particularly successful in trouble areas where it is difficult or impossible to provide lubrication. The built-in oil cushion absorbs heavy shocks and stresses.

Chrysler engineered OILITE bearings are made of various metals and alloys in a wide range of sizes for a multitude of uses. Standard bearings and bearing material (cored, bar and plate stock) are available from local dealers throughout the U.S. and Canada.

Contact Amplex for help with your bearing problems. The engineering facilities of Chrysler-Amplex are available to serve you. OILITE Field Engineers, Supply Depots and Dealers in all principal cities. Overseas distribution thru Chrysler Export.

Chrysler-Amplex also manufactures Permanent Metal Filters, Finished Machine Parts and Friction Units.

OILITE . . . *In Powder Metallurgy . . . It's Amplex*

CHRYSLER CORPORATION
AMPLEX DIVISION
Dept. F-6, Detroit 31, Michigan

IT'S NEW! IT'S FREE!
First complete information on self-lubricating bearings, finished machine parts, filters and other powder metal units. 52 pages. Write today for OILITE Engineering Manual E-55.

HERE'S AN UNUSUAL ECONOMY IN DESIGN AND PRODUCTION

2 different lamps—with 10 interchangeable parts!

CASE HISTORIES FRO
MT. VERNON FILES

These two handsome Acme* desk lamps have quite different bases—but aside from these, they were designed so that the several other parts required for each are identical and interchangeable. Naturally, this makes for great production economies reflected in sales.

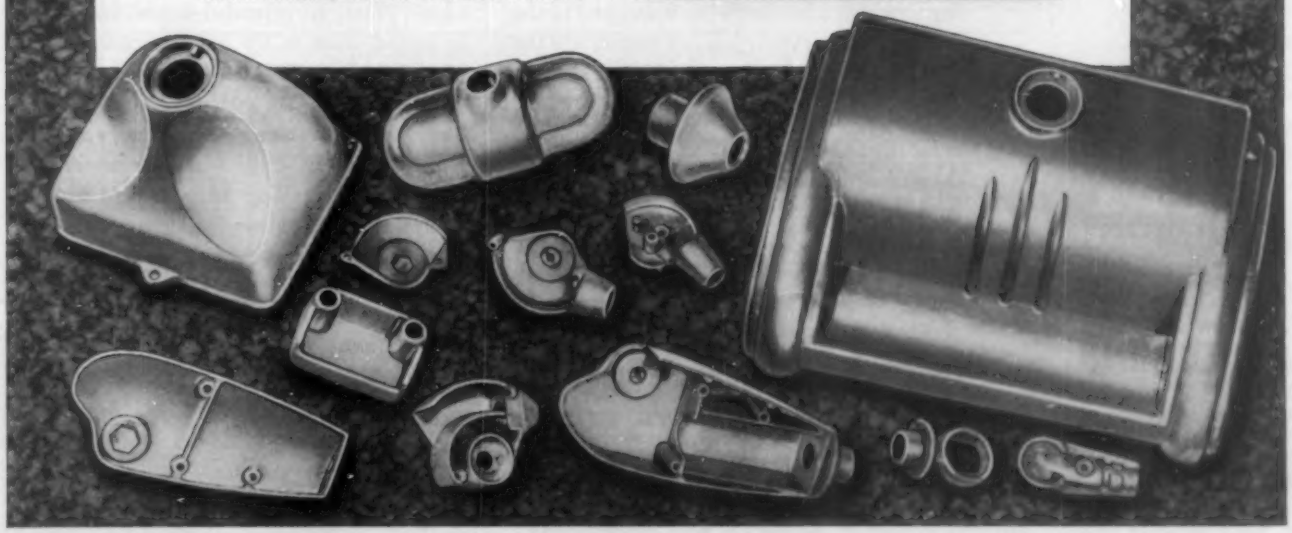
The same engineering brains that thought up this economy went directly ahead to an added economy—the use of die casting to make all these parts, including the two bases.

Die casting is the most economical method of producing these intricate parts—for these base clamps, articulating knuckles, and casings require thin wall sections with light weight yet with great strength.

Which is why Acme chose Mount Vernon. To make dies that will produce these varied parts at minimum cost takes experience, and extensive facilities. On both counts, Mount Vernon is the natural choice. We have a vast reservoir of experience to draw on; we have 162,000 square feet of the most modern equipment for making dies and die casting aluminum and zinc. Whether you need a single part or, like Acme, many parts, consult with us. We may show you the way to lower costs and improved products.

*Manufactured by Acme Light Products Co., Congers, N.Y.

MT. VERNON
DIE CASTING CORP.
STAMFORD, CONNECTICUT



See what adhesives are doing today!

Sealing trailers at the seams

When you consider the amount of weathering to which a house trailer is exposed in the course of its service, you can appreciate the importance of effective, all-around sealing.

Finding a seal to keep out dust, weather and noise used to present a real problem. But it doesn't any longer—thanks to 3M's new ribbon-like sealer, EC-1202. Made of synthetic rubber, EC-1202 is extremely flexible and easy to handle. And it's reinforced with sturdy fabric so that it holds its dimensions and is exceptionally easy to apply.

On trailers, like the one pictured above, EC-1202 is used to seal metal corners and edges. Next, an extruded aluminum corner is bolted over it for extra protection, to provide a complete seal against weathering of all sorts.

See what adhesives can do for you . . . You can use EC-1202 wherever metal corners, edges, or faying surfaces need sealing. Your 3M sales engineer will give you all the facts on this and the many other adhesives developed for industry. Call him, or write today for a free informative booklet—to 3M, Department 46, 417 Piquette Avenue, Detroit 2, Michigan.

3M ADHESIVES

ADHESIVES AND COATINGS DIVISION **MINNESOTA MINING AND MANUFACTURING COMPANY**

417 PIQUETTE AVE., DETROIT 2, MICH. • GENERAL SALES OFFICES: ST. PAUL 6, MINN. • EXPORT: 99 PARK AVE., N.Y. 16, N.Y. • CANADA: P.O. BOX 757, LONDON, ONT.

MAKERS OF "SCOTCH" BRAND PRESSURE-SENSITIVE ADHESIVE TAPES • "SCOTCH" BRAND SOUND-RECORDING TAPE • "SCOTCHLITE" BRAND REFLECTIVE SHEETINGS • "3M" ABRASIVE PAPER AND CLOTH • "3M" ADHESIVES AND COATINGS • "3M" ROOFING GRANULES • "3M" CHEMICALS

over 8,000 Different Cylinder SELECTIONS—

Miller AIR AND HYDRAULIC **CYLINDERS AND BOOSTERS**

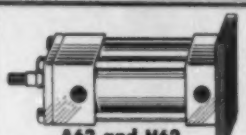
"IN STOCK" *for immediate delivery...*

See Miller Bulletins A-105K (Air) and H-104K (Hydraulic) for Complete Dimensions and Engineering Data on these "in-stock" sizes and other Custom Miller Cylinders in bores up to 20" and strokes up to 22 feet.

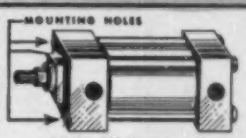
"IN-STOCK" MODELS

"A" Signifies Miller 200 psi Air Cylinders; "H", 2000 psi Hydraulic Cylinders. Interchangeable Mountings Are Shown In Red On Drawings.

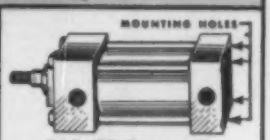
A61 and H61 Flange Mounting on Rod End (A61 not available in 8" bore)



A62 and H62 Flange Mounting on Cap End (A62 not available in 8" bore)

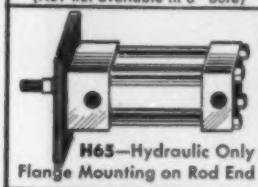


A63—8" Bore only Flange Mounting on Rod End

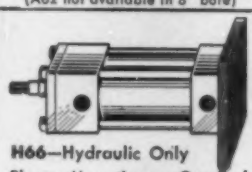


A64—8" Bore only Flange Mounting on Cap End

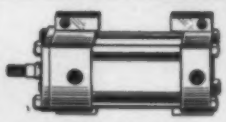
A50 & H50—Tie Rods not extended beyond nuts.
A51 & H51—Tie Rods extended both ends (shown).
A52 & H52—Tie Rods extended. Cap End only.
A53 & H53—Tie Rods Extended. Rod End only.
A54 & H54—Two Tie Rods extended at both ends.



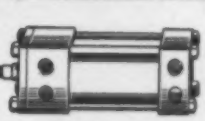
H65—Hydraulic Only Flange Mounting on Rod End



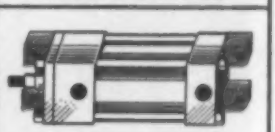
H66—Hydraulic Only Flange Mounting on Cap End



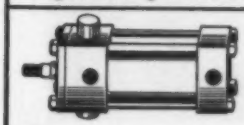
A72 and H72 Side Lug Mounting



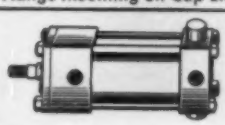
A74 and H74 Side Flush Mounting



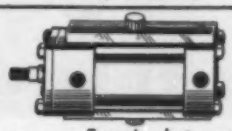
A77 and H77 Side or Foot Mounting



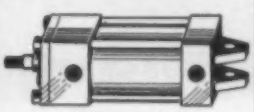
A81 and H81 Trunnion Mounting on Rod End



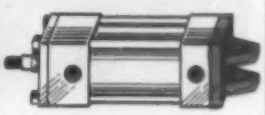
A82 and H82 Trunnion Mounting on Cap End



A83 and H83 Trunnion between Head and Cap (one week delivery)



A84 and H84 Pivot Mounting



A86 and H86 Pivot Mounting

IN STOCK BORES In Inches

"IN-STOCK" STROKES (in Inches)

	Bores	Rod Dia.	Rod Turn Down & Threads		1	2	3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
AIR	1½	⅝"	7/16-20	Cushioned			3	4	5	6	7	8	9	10	11	12									
				Non-Cush.	1	2	3	4	5	6	7	8	9	10	11	12									
	2	⅝"	7/16-20	Cushioned			3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
				Non-Cush.	1	2	3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
	2½	⅝"	7/16-20	Cushioned			3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
				Non-Cush.	1	2	3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
	3¼	1"	¾-16	Cushioned			3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
				Non-Cush.	1	2	3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
	4	1"	¾-16	Cushioned			3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
				Non-Cush.	1	2	3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
	5	1"	¾-16	Cushioned			3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
				Non-Cush.	1	2	3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
	6	1⅜"	1-14	Cushioned			3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
				Non-Cush.	1	2	3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
	8	1⅜"	1-14	Cushioned			3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
				Non-Cush.	1	2	3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
HYDRAULIC	1½	⅝"	7/16-20	Cushioned			3	4	5	6	7	8	9	10	11	12									
				Non-Cush.	1	2	3	4	5	6	7	8	9	10	11	12									
	2	1"	¾-16	Cushioned			3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
				Non-Cush.	1	2	3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
	2½	1"	¾-16	Cushioned			3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
				Non-Cush.	1	2	3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
	3¼	1⅜"	1-14	Cushioned			3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
				Non-Cush.	1	2	3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
	4	1¾"	1¼-12	Cushioned			3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
				Non-Cush.	1	2	3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
	5	2"	1½-12	Cushioned			3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
				Non-Cush.	1	2	3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36

(1) (2) (3) (4)

"A" and "H" Models 82, 84 and 86 with strokes over 18" require stop tubes.

Column strength requires larger diameter piston rods for the following:

Air Cylinder Models A82, 84, and 86 with strokes inside area (1), when operated at 100 psi and over;

All hydraulic models with strokes inside area (2) and Models H82, 84, and 86 with strokes in area (4), when operated at 2000 psi and over;

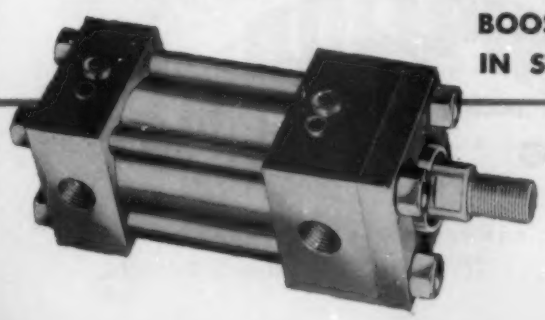
Models H82, 84 and 86 with strokes inside area (3), when operated at 1000 psi and over.

Depending upon Trunnion Pin location, "A" and "H" Models 83 with standard diameter piston rods can have longer strokes than Models 82, 84 and 86.

See Miller File #251 for oversize piston rod and stop tube requirements.

BOOSTERS IN STOCK

Immediate Delivery on the following Miller 25 to 1 Ratio Boosters (80 psi air input produces 2000 psi hydraulic oil output): Model 84, 5" bore, 1" dia. ram, 6" and 12" strokes; Reciprocating Booster Model DA77-RBA8, 5" bore, 1" dia. ram, 6" stroke. Also Booster Tanks, 5" dia., 6" and 10" heights.



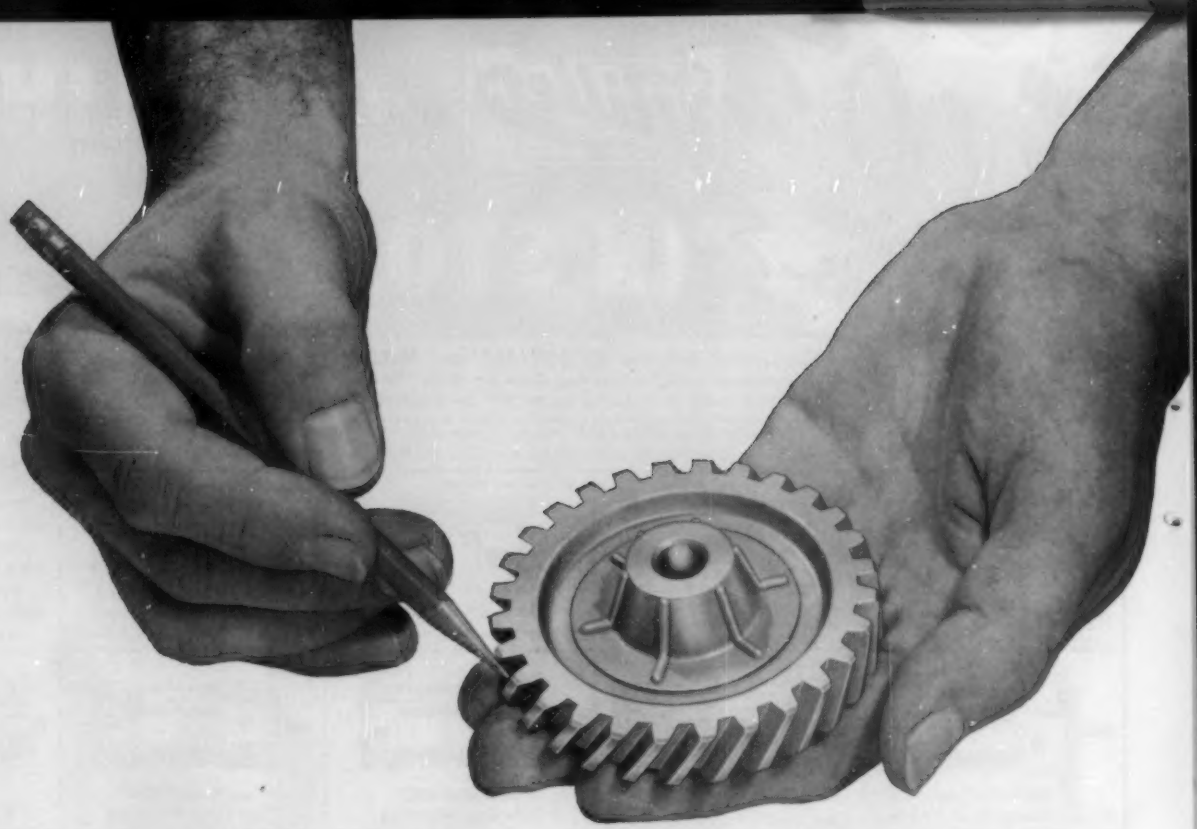
Write For Catalog and Stock Price List

Miller

MILLER FLUID POWER CO.

2002-04 N. Hawthorne Ave. Melrose Park, Ill.

AIR & HYDRAULIC CYLINDERS • BOOSTERS • ACCUMULATORS
COUNTERBALANCE CYLINDERS



they thought this die casting couldn't be made...

● But **Stewart** turned out over 12,000 a week!

This helical gear is one example of an old habit at Stewart Die Casting—"finding a way." In 45 years, we have produced many castings that "couldn't be made." Whatever type of die castings you need—small or large, simple or intricate—count on *Stewart* to meet your most rigid specifications . . . on time.

SERVICES AVAILABLE . . .

Designing • Engineering • Die Making
Metallurgical Control • Most Modern Die Casting Equipment • Complete Machining, Polishing and Assembly Facilities.

45 years of helping industry to "Make It Better"

Stewart **DIE CASTING**

. . . a division of STEWART SW WARNER

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ANNOUNCING...

the Beryllium Copper ROLLPIN®

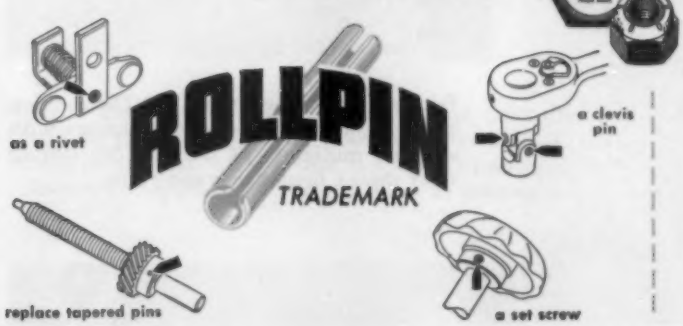
Strong . . . highly resistant to corrosion . . . nonmagnetic . . . extremely conductive

Now you can use Rollpin to cut assembly and maintenance costs in a whole new group of applications. A new line made of beryllium copper, one of the strongest of the copper base alloys, opens the door to a wide variety of uses where resistance to corrosive attack, good electrical properties and other unusual characteristics are required. These slotted tubular copper spring-pins can be used in assemblies that range from plumbing fixtures to electrical instruments, particularly in conjunction with other copper base alloy components.

Rollpin has already established its ability to replace taper pins, straight pins and set screws; to serve as a rivet, dowel, hinge pin, cotter pin or stop pin . . . eliminating special machining, tapping and the need for hole reaming or precision tolerances. Driven into a hole drilled to normal production standards, it locks securely in place, yet can be readily drifted out and reused whenever necessary.

Rollpin is available in beryllium copper from .062″-diameter to .250″-diameter, and in steel and stainless steel up to .500″-diameter.

ELASTIC STOP NUT (ESNA) **CORPORATION OF AMERICA**



Dept. R35-62, Elastic Stop Nut Corporation of America
2330 Vauxhall Road, Union, New Jersey

Please send me the following free fastening information:

☐ Data on beryllium copper Rollpin

☐ Here is a drawing of our product. What self-locking fastener would you suggest?

Name_____ Title_____

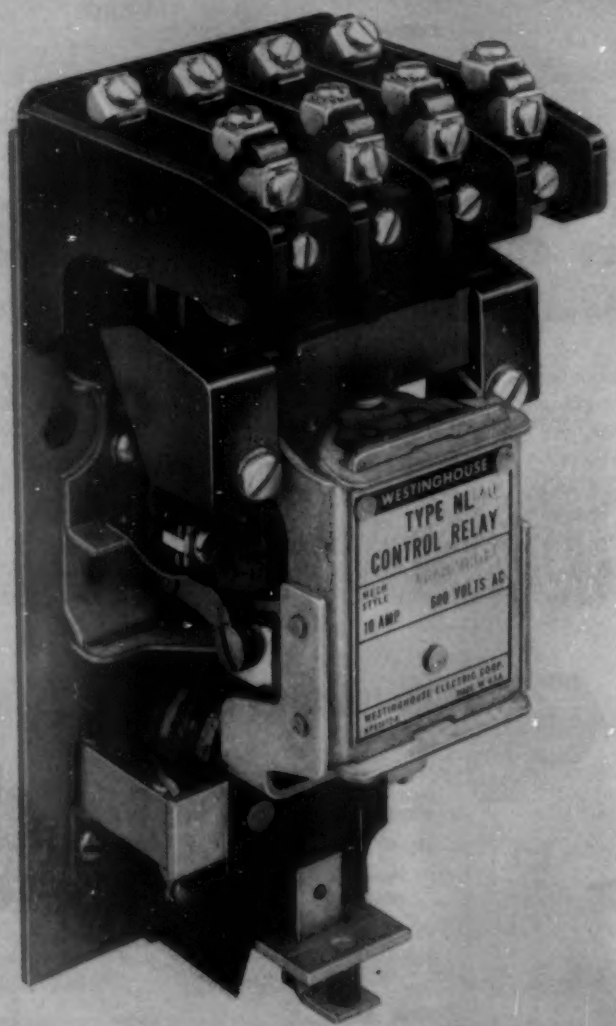
Firm_____

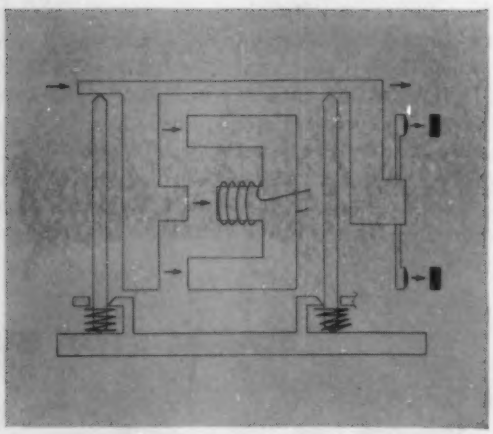
Street_____

City_____ Zone_____ State_____

TYPE N CONTROL RELAY

TYPE NL CONTROL RELAY
(Mechanically held)





Friction-Free Operation . . . The moving armature assembly rides on fulcrums with absolute minimum of friction. No sliding wear means longer operating life.

New Westinghouse control relays

for pilot circuits, automatic control and sequencing operations

Specially designed friction-free bearings—exclusive with Westinghouse—eliminate sticking or jamming and sliding wear. That's why the new Westinghouse control relays are *always* dependable—stay on the job longer.

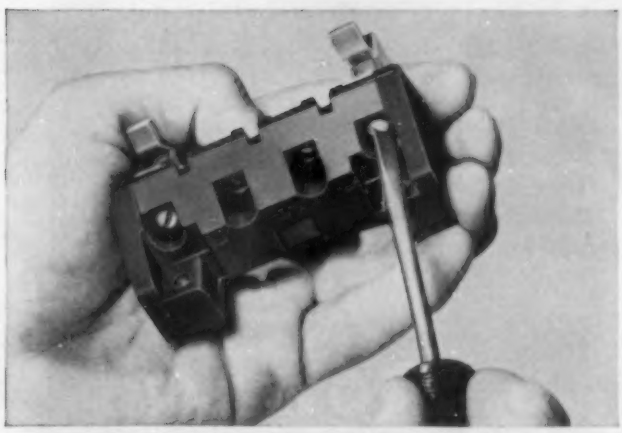
Designed particularly for any circuits involving rapid openings and closings. Positive action, kick-out spring provides rapid, dependable operation.

Rated at 10 amperes (open). Available in any combination of normally open or normally closed contacts; 2, 3, 4 or 6 pole for any voltage up to 600 volts a-c; and either open or in standard NEMA enclosures for specific applications.

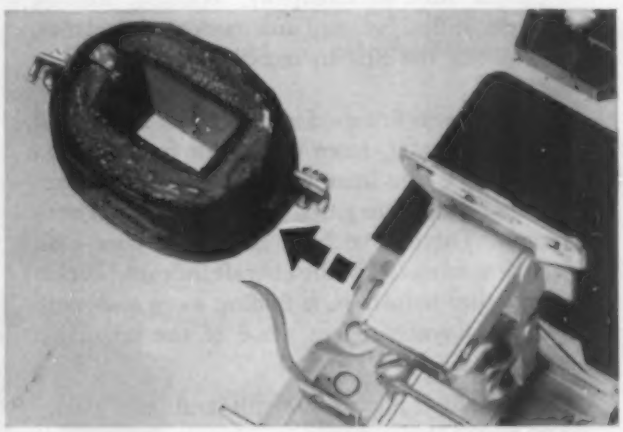
For *all* the facts, call the control sales engineer at your nearest Westinghouse office, *The Man With The Facts!* J-30187

YOU CAN BE SURE...IF IT'S

Westinghouse



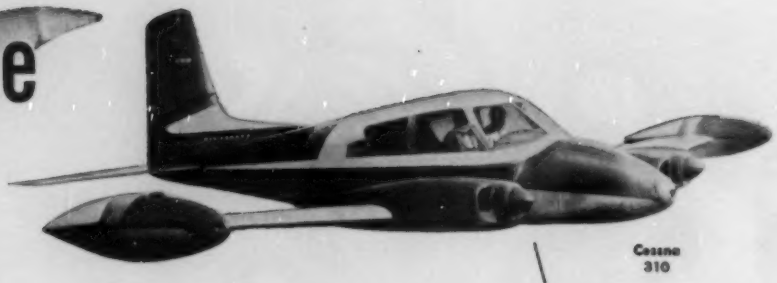
Easier Contact Changes . . . Switch from normally open position to normally closed position, or vice versa, easily made in the field. All you need is a standard screw driver—there are no parts to add or any wires to disconnect.



Easily Accessible Parts . . . Removing the magnet coil from the relay is quickly accomplished as evidenced by the above photograph of the magnet coil and retaining spring. All other parts are equally accessible—easy to get at.

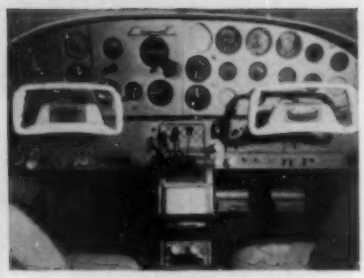
U. S. Royalite wins its wings

in the aircraft industry

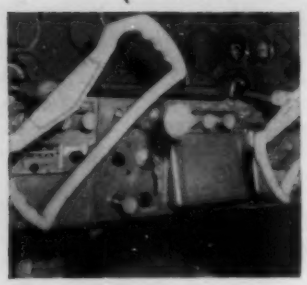


Cessna 310

Cessna 180



Cessna 170



Tough, versatile Royalite has found increasing and diversified uses in the aircraft industry.

Cessna Aircraft Company, Wichita, Kansas, builders of fine personal and executive airplanes, was among the first to recognize Royalite's advantages.

Royalite was first used in the Cessna 170 several years ago. Later, more uses were found in the Cessna 180. The luxurious new Cessna 310 has even more Royalite parts, many in the handsome interior. There have been increasing uses with each new model. Yes, the aircraft industry, like so many other industries, is finding more and more uses for Royalite. Here are 6 of the important reasons:

- Tough, high impact strength, and long wear.
- Beauty and durability of color and grain finish.
- Lighter weight than commonly used metals.
- Low tooling costs and inexpensive forming operations.
- Resistant to most oils, acids and chemicals.
- Engineering and design versatility for contours and sharp detail.

Manufacturers in almost every field have used Royalite in solving production and cost problems. There's a Royalite use for *your* product. Get all of the facts. See how Royalite can improve appearance and performance—*and cut costs.*

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TOUGH, VERSATILE FABRICATING MATERIAL

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STAINLESS STEEL FOR BUILDINGS

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High quality stainless sheet and strip steel . . . for the product you make today and the product you plan for tomorrow.

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TAYLOR Laminated Plastics Vulcanized Fibre

Shop Talk

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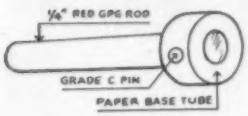
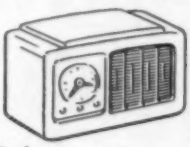
PHENOL—MELAMINE—SILICONE—EPOXY LAMINATES • COMBINATION LAMINATES • VULCANIZED FIBRE • POLYESTER GLASS ROD

Tips for designers



Reset cam button is made of Taylor Polyester Glass Rod. Colored all the way through, it needs no painting or machining. Color never wears off.

Strong, silent gears are readily machined out of Taylor fabric base phenol laminates . . . noted for high mechanical strength.

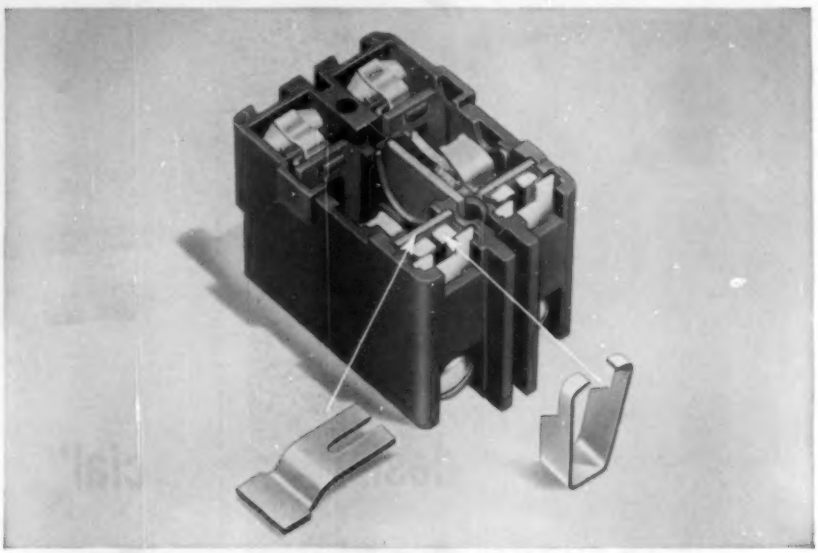


Perforated sheets of Taylor Vulcanized Fibre or Taylor Phenol Laminates make economical, high-strength speaker grilles for radio and TV sets.

Pop-up toaster switch and relay insulation was changed from laminated mica to Taylor G-5 Laminate . . . for easier fabrication and excellent heat resistance.

TAYLOR FABRICATING FACILITIES

Your production can be simplified . . . schedules safeguarded . . . inventory headaches cured . . . and overall costs reduced by having Taylor fabricate finished parts to your specifications. Efficient, modern facilities are ready to serve you. Get in touch with Taylor about your specific requirements.



Arc chutes in this circuit breaker are made of Taylor Vulcanized Fibre . . . noted for its arc resistance and electrical insulating properties.

Versatile properties, reasonable cost — try Taylor Vulcanized Fibre

Next time you tackle a materials problem in product design take a look at Taylor Vulcanized Fibre. A time-proved material with thousands of known applications, Taylor Vulcanized Fibre is finding new uses every day. Why? Because it offers a wide range of properties at low cost, places at your disposal a unique combination of performance and economy characteristics.

It's an excellent insulator . . . widely used in electric motors, transformers, appliances and scores of like products.

It's arc-resistant . . . does not readily carbonize and form arc paths, won't track due to air arcs. Use it in arc chambers and chutes in circuit breakers and switches.

It's strong . . . has excellent tensile and compressive properties, resists wear and abrasion. Use it in gaskets, washers, cams, workbench tops, sanding discs, and other structural parts.

It's resilient . . . takes severe shock without permanent deformation. Use it for inserts in golf clubs, for bumper blocks . . . anywhere you need high impact resistance.

It machines to high finish . . . produces smooth, long-wearing surfaces. Use it in textile shuttles and bobbins and other parts.

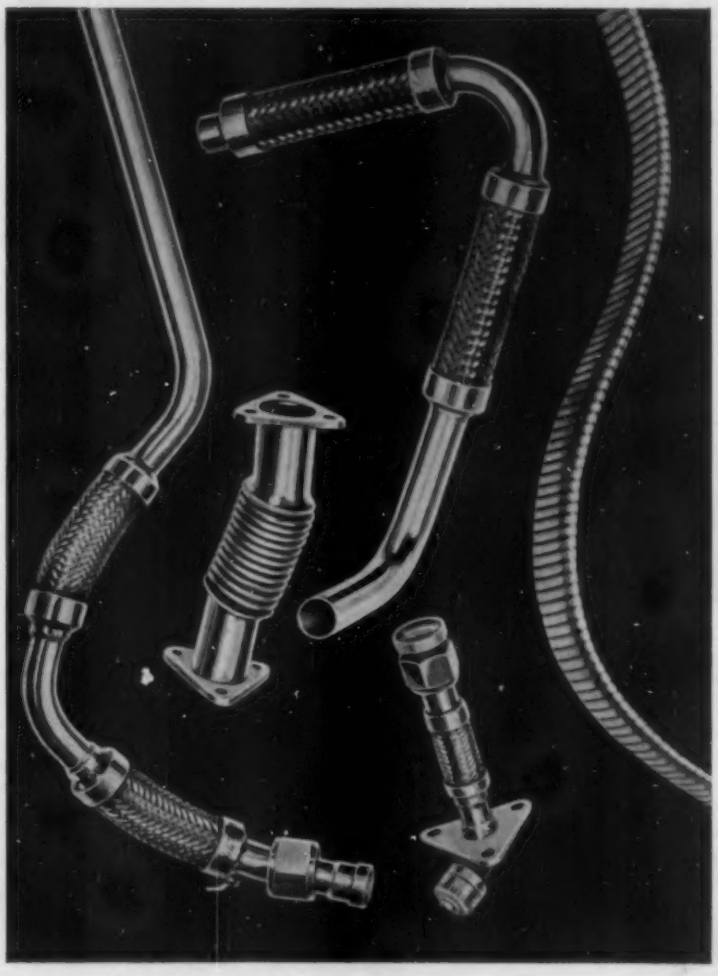
It bonds readily . . . to itself, to wood or to other materials. Use it in luggage, receptacles and mill boxes.

It's economical to fabricate . . . provides real cost savings in punching, stamping, drilling, cutting and forming.

Actually, these are only a sample of the applications that keep developing for Taylor Vulcanized Fibre. It comes in a choice of eight different grades, and in a variety of colors. It is supplied in the largest sheet size in the industry . . . also in rolls, strips and turned rods. A Taylor representative near you will be glad to discuss ways that you can put this material to work in your products.

Standard AMERICAN flexible connectors like these may solve your problem . . .

If not, we'll design a "special" at no extra cost



What's your connector problem? Vibration? Movement? Misalignment? Cramped space? Want help solving it? Tell us what material you have to convey, temperatures and pressures involved, kind of end fittings you need, and the special conditions which will affect service. Our engineers will be glad to work with you. *The American Brass Company, American Metal Hose Branch, Waterbury 20, Conn.* In Canada: *The Canadian Fairbanks-Morse Co., Ltd.*

55178

WHEREVER CONNECTORS MUST MOVE

AMERICAN

flexible metal hose and tubing

an ANACONDA® product

PRE

FREE CATALOG . . . 16 pages of data on the complete line of American Flexible Metal Hose and Tubing, including fittings. Mail coupon to The American Brass Company, American Metal Hose Branch, Waterbury 20, Conn.

NAME.....

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Here's the modern way to end lubrication troubles —install Farval

FARVAL—
Studies in Centralized Lubrication
No. 163

WHAT if your oiler uses the wrong oil or grease? Or maybe he's in a hurry and forgets a few bearings. Whatever the error, bearings may be ruined. A machine is down and expenses begin. All such troubles can be avoided by installing Farval Centralized Lubrication.

With Farval a measured amount of the *right* lubricant is hydraulically delivered whenever needed to the bearings of a machine. *No bearings are ever missed!* A "tell-tale" indicator at each bearing gives *positive proof* that the measuring valve has functioned and that the bearing has received the lubricant it needs.

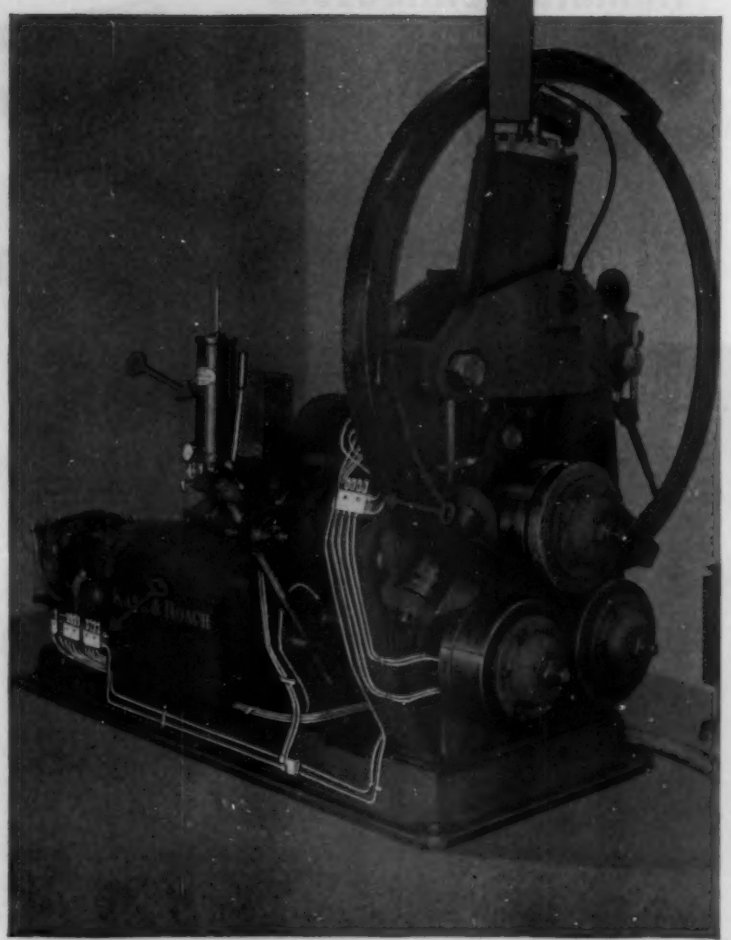
Kane & Roach Installs Farval

This Kane & Roach Vertical Angle Bender is an excellent example of how one modern machinery builder protects his equipment from "human" error. According to this builder, the cost of just *one* shutdown due to haphazard lubrication would exceed the entire cost of its protective Farval system. With Farval installed, this machine can perform efficiently, with no danger of bearing failure. In addition, Farval saves oiling labor and lubricant!

Free Lubrication Survey

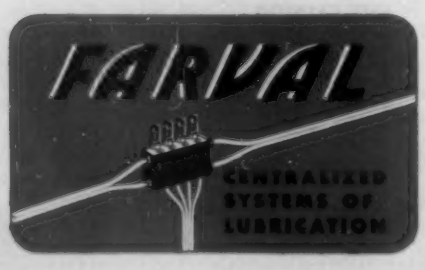
Why not let us send a Farval engineer to inspect your plant equipment? Without obligation, he will present a written analysis of how Farval can end your lubrication troubles. Write also for Bulletin 26 for the complete Farval story. The Farval Corporation, 3279 East 80th Street, Cleveland 4, Ohio.

Affiliate of The Cleveland Worm & Gear Company, Industrial Worm Gearing. In Canada: Peacock Brothers Limited.



KEYS TO ADEQUATE LUBRICATION—**Wherever you see the sign of Farval—the familiar valve manifolds, dual lubricant lines and central pumping station—you know a machine is being properly lubricated. Farval manually operated and automatic systems protect millions of industrial bearings.**

Pictured is a *Farvalized* Kane & Roach Vertical Angle Bender (Model 23) used for bending angles, channels, rounds, squares and other shapes.



Stainless Steel bulb for color television tube by I-T-E Circuit Breaker Co., Philadelphia, Pa.

Spinning Stainless Steel circles into cone.

Forming cone on 500-ton hydraulic press.

How Stainless Steel helps I-T-E put color into television

Television is opening up a whole, wide wonderful world of color and Stainless Steel is playing an important part in this great advancement. I-T-E Circuit Breaker Company is manufacturing the bulb assembly for color television using cones made from Stainless Steel.

The advantages lie in the light weight made possible by metal shell construction—a highly important consideration at this stage of color tube development—the safety factor of a metal-glass tube and the ability to use a higher-quality glass in the picture surface. Stainless Steel's coefficient of thermal expansion makes it a suitable material for a metal-glass bond.

I-T-E's choice of Stainless Type 430 for its color TV development was a natural as they have produced millions of Stainless Type 430 cones for black and white picture tubes ranging from 8½" diameter sizes to 27" rectangulars.

Stainless Steel's unique combination of properties merits consideration in all types of design problems. And it's not a difficult material to fabricate. Investigate Stainless Steel for your products, and when you do, be sure to use service-tested USS Stainless Steel.

FABRICATING FACTS

For the bulb circles of USS Stainless Steel .125" thick are used. Circles are shear formed on a spinning lathe to produce a cone 21" in diameter, tapering to 8" by 14" deep.

Cone is further formed on 500-ton press. Panel is sheared from funnel, flanges are formed and deburred and both parts sandblasted to receive glass.

SEE The United States Steel Hour.
It's a full-hour TV program presented every other week by United States Steel. Consult your local newspaper for time and station.

UNITED STATES STEEL CORPORATION, PITTSBURGH • AMERICAN STEEL & WIRE DIVISION, CLEVELAND
COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO • NATIONAL TUBE DIVISION, PITTSBURGH
TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA.
UNITED STATES STEEL SUPPLY DIVISION, WAREHOUSE DISTRIBUTORS
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USS

USS STAINLESS STEEL

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UNITED STATES STEEL

Now! a new line of A. O. Smith jet pump motors

Primary functional parts totally enclosed—Exclusive "sure-snap" starting switch, capacitors and automatic overload protector—all totally enclosed to protect performance.

Pioneer producer of a full jet pump motor line —backed by millions of units in service — A. O. Smith offers you great new models with application-engineered advantages. Your choice of single and three-phase design — ⅓ through 2 hp.

CANOPY PROTECTION FOR VITAL COMPONENTS

Totally enclosed grouping locks out dirt, dust and other foreign matter. Vital parts stay clean for more years of dependable service.

POSITIVE VENTILATION

Controlled cooling further promotes long life and low maintenance. Generous intake and discharge louvers, large, shaft-mounted fan, ample air-space behind stator core assure adequate and uniform cooling of windings and rotating parts.

READY FOR OTHER APPLICATIONS

These new motors pack dramatic versatility. They make good sense to manufacturers who want the advantages of totally enclosed design at a cost far lower than conventional models of this type.

Get all the facts about these great new performers as well as the other motors made by A. O. Smith. Ask the representative who calls on you . . . or write A. O. Smith Corporation, Electric Motor Division, P. O. Box 170, Dayton, Ohio.

Through research ...a better way

A.O.Smith
CORPORATION
ELECTRIC MOTOR DIVISION
P. O. Box 170 • Dayton, Ohio
International Division: Milwaukee 1, Wisconsin

How to use
New USS "T-1" Steel
to reduce welding costs

New USS "T-1" Steel is three times as strong as ordinary mild steel . . . has a yield strength of 90,000 psi.

Yet, despite its very high strength, this new alloy steel is *easy to weld*. It requires neither pre- nor post-heating when you weld or flame cut it. You can use its unique combination of properties to reduce fabricating costs and speed assembly in pressure vessels, construction machinery, mining equipment, bridges, towers, and pipe.

USE "T-1" TO REDUCE THICKNESS. You can take advantage of the exceptionally high yield strength of "T-1" Steel to reduce the size and weight of heavily stressed parts. Weldments on thinner sections take less time . . . and less welding rod.

FABRICATE "T-1" IN THE FIELD. You can weld "T-1" Steel *anywhere*. Since no pre- or post-heating is needed, you don't have to confine fabrication to locations where heat treating facilities are available. You can assemble heavy-duty equipment in the field, and you can repair it in the field—at great savings.

WHAT ABOUT JOINT EFFICIENCY? Weldments in "T-1" Steel develop the full yield strength of the steel — 90,000 psi.—when made with AWS E12015 low hydrogen coated electrodes *without* pre- or post-heating. As a result, weight reducing designs based on the greater strength of "T-1" Steel are completely safe and reliable.

Send the coupon for complete facts about this amazing new alloy steel.

United States Steel, Room 4750
525 William Penn Place, Pittsburgh 30, Pa.

☐ Please send me your booklet "United States Steel presents T-1" which contains the full story of "T-1" steel.

☐ Have your representative get in touch with me.

Name .....

Address .....

City ..... State .....

UNITED STATES STEEL CORPORATION, PITTSBURGH • COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO
TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA. • UNITED STATES STEEL SUPPLY DIVISION, WAREHOUSE DISTRIBUTORS
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

USS "T1" CONSTRUCTIONAL ALLOY STEEL

SEE THE UNITED STATES STEEL HOUR. It's a full-hour TV program presented every other week by United States Steel. Consult your local newspaper for time and station.

USS

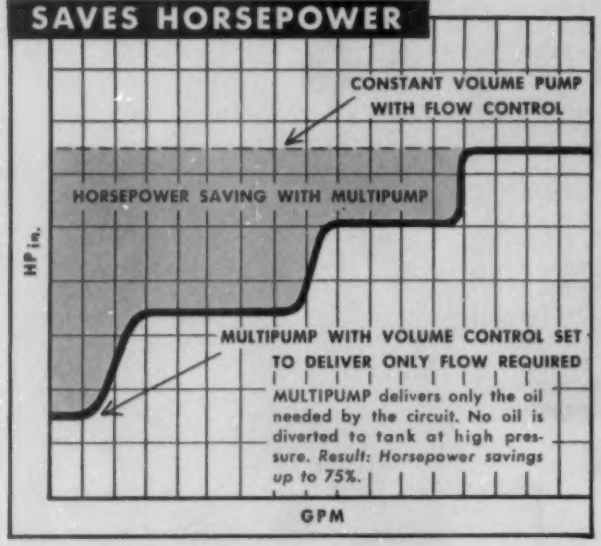
5-477

UNITED STATES STEEL

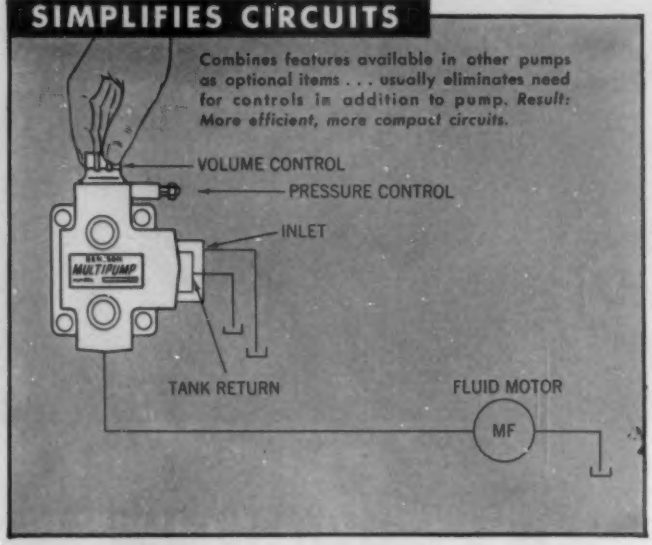
New 1000 psi variable volume vane pump

Denison MULTIPUMP delivers variable volume at constant speed... delivers constant volume at variable speed. *Here's how you can benefit:*

SAVES HORSEPOWER

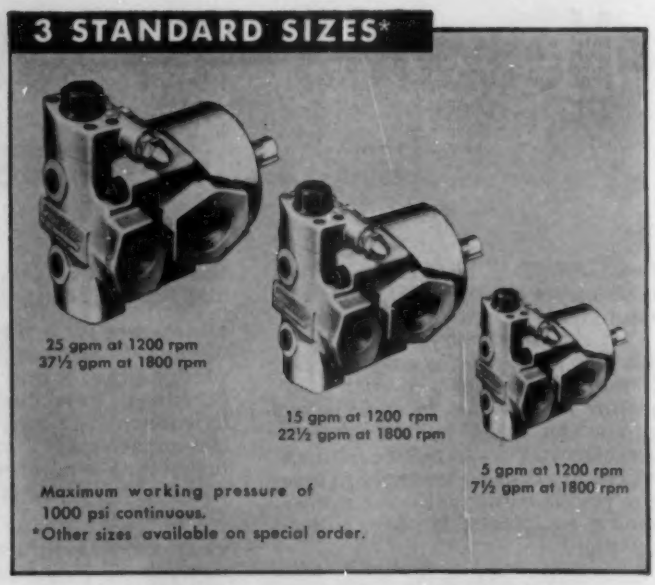

CONSTANT VOLUME PUMP WITH FLOW CONTROL
HORSEPOWER SAVING WITH MULTIPUMP
HP in.
MULTIPUMP WITH VOLUME CONTROL SET TO DELIVER ONLY FLOW REQUIRED
MULTIPUMP delivers only the oil needed by the circuit. No oil is diverted to tank at high pressure. Result: Horsepower savings up to 75%.
GPM

SIMPLIFIES CIRCUITS


Combines features available in other pumps as optional items . . . usually eliminates need for controls in addition to pump. Result: More efficient, more compact circuits.
VOLUME CONTROL
PRESSURE CONTROL
INLET
MULTIPUMP
TANK RETURN
FLUID MOTOR
MF

FINGER-TIP CONTROL

3 STANDARD SIZES*


25 gpm at 1200 rpm
37½ gpm at 1800 rpm
15 gpm at 1200 rpm
22½ gpm at 1800 rpm
5 gpm at 1200 rpm
7½ gpm at 1800 rpm
Maximum working pressure of 1000 psi continuous.
*Other sizes available on special order.

First again! Denison's MULTIPUMP introduces a new, exclusive hydraulic pumping principle of major importance to industry. Learn how it can cut operating costs of your hydraulic systems. Write Denison, ask for Bulletin 190.

THE DENISON ENGINEERING COMPANY
1194 Dublin Road • Columbus 16, Ohio

DENISON HydrOILics

HYDRAULIC PRESSES • PUMPS
MOTORS • CONTROLS

In this heat exchanger for gas furnaces

Switch to USS COR-TEN Steel extends service life 2 to 3 times

The superior resistance to atmospheric corrosion provided by USS COR-TEN Steel pays off in several ways for the Hall-Neal Furnace Company, Indianapolis, Ind.

This company makes the Victorgas unit, a heat exchanger for domestic gas furnaces. When built of plain carbon steel these units were quite vulnerable to corrosion, and service life was not as long as desired. Corrosion was encountered when furnaces were down during the summer months. Damage due to condensation of water vapor and the products of gas combustion was particularly severe in intermittent service.

By changing to USS COR-TEN Steel, which has 4 to 6 times the atmospheric corrosion resistance of carbon steel, it was possible to extend the service life of these units 2 to 3 times. This achievement not only pleases the furnace makers but makes for greater customer acceptance and helps to boost furnace sales.

USS COR-TEN Steel's ability to form and weld readily, and to safely withstand furnace temperatures up to 1000° F. are other advantages which, added to superior corrosion resistance, far offset its slightly higher cost.

USS MAN-TEN Steel used in portable scaffolds reduces weight 19%,

provides greater strength and durability

These portable work scaffolds manufactured by Baker-Roos, Inc., Indianapolis, Ind., are adjusted and moved more easily, and are more rugged and durable because side rails were redesigned to incorporate USS MAN-TEN Steel.

Used by builders, painters, electricians, carpenters and maintenance men in all types of off-the-floor work, the "no X-brace" construction of Baker-Roos scaffolds allows them to span furniture and equipment so that regular production will not be interrupted in occupied areas.

This type of construction and function requires a combination of strength and light weight for maneuverability. To improve the scaffold in these respects, the side rails were changed from carbon steel angles, 1½" x 1½" x 3/16", to a section formed from MAN-TEN Steel hot rolled strip, .0747" x 5½".

This has reduced side rail weight 19% making it easier to shift the scaffold from job to job. And even though USS MAN-TEN Steel is used in lighter sections, the fact that this steel is one and a half times stronger than carbon steel and has 40% higher fatigue strength ensures a stronger and more durable side rail than before.

NOW AVAILABLE . . . Our new "Design Manual for High Strength Steels" is ready for distribution. This excellent book contains comprehensive and practical information that you will find extremely useful in designing your product for greater economy and efficiency by the sound use of high strength steels. For your free copy, write on your company letterhead, giving your title or department, to United States Steel Corporation, Room 4720, 525 William Penn Place, Pittsburgh 30, Pa.

UNITED STATES STEEL CORPORATION, PITTSBURGH • AMERICAN STEEL & WIRE DIVISION, CLEVELAND • COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO
NATIONAL TUBE DIVISION, PITTSBURGH • TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA. • UNITED STATES STEEL SUPPLY DIVISION, WAREHOUSE DISTRIBUTORS
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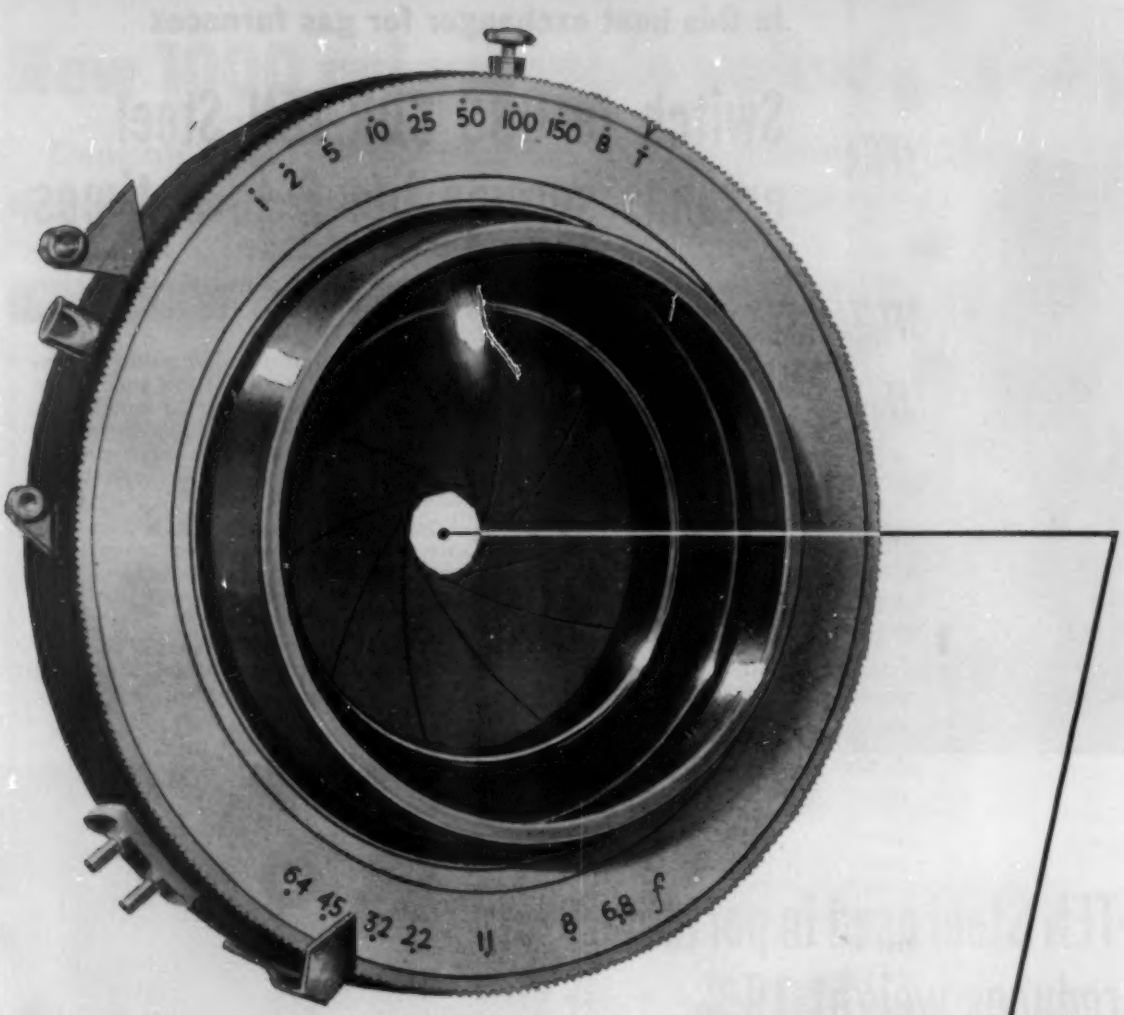
USS HIGH STRENGTH STEELS

USS MAN-TEN • USS COR-TEN • USS TRI-TEN

UNITED STATES STEEL



We roll tissue-thin steel so flat

a camera's eye shuts tighter

● Camera shutters are incredibly fast and accurate. To permit this speed and precision, *Athenia Steel Division* rolls tough alloy steel to a thickness of .002″ . . . with a tolerance of only .0001″.

But the toughest part of the job is keeping the steel extremely *flat*. It requires skill of the highest order, plus constant supervision and meticulous control.

The *Athenia Steel Division* of National-Standard produces this steel for the foremost camera makers, meeting these really tough specifications better than they've ever been met before.

Tough jobs like this are routine at *Athenia*. We can roll the fussiest kinds of steel to remarkable tolerances.

We can meet any demands for high carbon strip steel. But we excel at producing the types with specifications so extreme that other manufacturers cannot or will not meet them. And we are just as eager to serve the small manufacturers as the big ones. Write us and see.

NS
NATIONAL-STANDARD Company
NILES, MICHIGAN

NATIONAL-STANDARD COMPANY • NILES, MICHIGAN
Tire Wire, Stainless, Fabricated Braids and Tape
ATHENIA STEEL DIVISION • CLIFTON, N. J.
Flat, High Carbon, Cold Rolled Spring Steel
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Special Machinery for Metal Decorating
WORCESTER WIRE WORKS DIVISION • WORCESTER, MASS.
Round and Shaped Steel Wire, Small Sizes

ASCO

the one source for RELAYS that offers engineers complete design flexibility

The designer confronted with the specification of a relay has a genuinely unusual opportunity when he discusses his problem with an ASCO engineer. For the ASCO representative can suggest a relay for use as a unit, or as a control panel component, and meet the designer's need *exactly:*

ASCO offers both magnetically and mechanically held relays — both available with up to 12 poles normally open or normally closed — in 10 and 25 ampere sizes, AC and DC.

In addition, ASCO lists a highly diversified line of special purpose relays as *standard catalog items.*

Finally, should any of these relays fail to meet specialized requirements — ASCO will design and manufacture one or more that will.

And most important —

For assured performance, ASCO Relays are current and voltage rated "make" and "break". Almost unlimited pole combinations mean fewer relays in a system — more reliable operation. Adaptability of many proven contact materials, arcing contacts, blowout coils and Class H insulating materials to ASCO Relays means suitability for all applications.

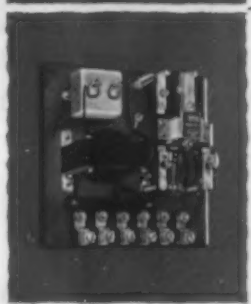
With this complete flexibility the designer can select a relay that meets his requirements, rather than have the relay limit his design.

There's *one* source that solves virtually any relay problem — ASCO. Why not have the ASCO engineer call — or write outlining your relay problem. We'll be pleased to assist you.

Reverse Current Relays — To disconnect DC generators from the batteries which they are charging when current flows from the batteries to the generators.

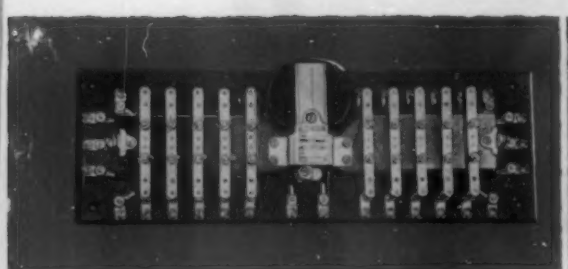
Electronic Relays — Extremely sensitive, for high speed response. "Brushing" of control leads — even momentarily — provides positive relay operation. Available, too, with time delay.

Time Delay Relays — That handle motor loads directly. Simple screwdriver adjustment makes possible delays from ½ to 6 seconds at any standard voltage. Used extensively on new brake winding motors.

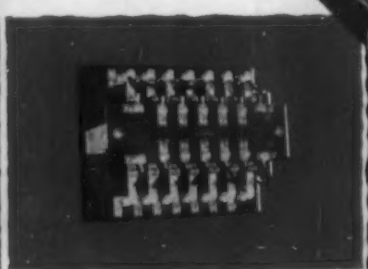


Close Differential Relays — Operate on voltage or current differential of 2% — less if required. Adjustable drop-out is standard. Adjustable pick-up is available.

Current Relays — "Coil-less" type, designed to function like a current transformer. Load cable through relay provides magnetic field for relay operation.



Many application requirements are met and surpassed with standard ASCO Magnetically Held Relays. For example, the Bulletin 1055 Relay adapts readily to such specialized control applications as control circuit transfer relays and mechanically interlocked relays for reversing motors.



This standard ASCO Mechanically Held Relay—Bulletin 1256—withstands severe shock and vibration—is used extensively for mobile units, central station control units and circuit transfer relays.

ASCO®

Automatic Transfer Switches
Electromagnetic Controls
Solenoid Valves

Automatic Switch Co.

385 Lakeside Avenue • Orange, New Jersey

Mass-Produced at Less Cost...

by HAYNES Investment Casting
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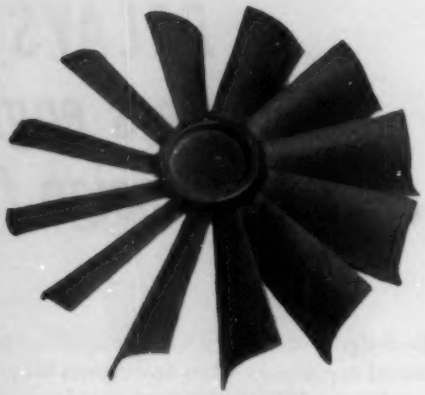

PRODUCED FOR 74 PER CENT LESS

Originally this turbine wheel was machined from a 20-lb. forging to a final weight of a little over 1 lb. Now the part is produced by investment casting and only 2 oz. of metal is removed. Investment casting has brought about a 74 per cent reduction in production costs by saving strategic metal and machine time.

COST CUT 60 PER CENT

This investment-cast motor mount was made in a high-strength alloy at 60 per cent less than the cost of a forging. The mount bears the entire weight and torque of a 100-lb., 15-horsepower aircraft starter motor. The investment-cast parts require only four simple finishing operations.

ASSEMBLY COSTS REDUCED

Investment casting made it possible to produce this cylinder head in one piece, eliminating extra assembly costs. Machining was reduced to a minimum. The design of the part is special to investment casting. The castings weigh about 25 lb. and are 7 in. in diameter.

HAYNES *investment castings can solve some of your own production problems. For more information, contact the nearest Haynes Stellite Company office listed below.*

"Haynes" is a registered trade-mark of Union Carbide and Carbon Corporation.

HAYNES INVESTMENT CASTINGS
TRADE-MARK

Sound, dense, high-strength parts available in cobalt-base alloys, nickel-base alloys, iron-base alloys, stainless steels, and alloy and carbon steel.

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UCC
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when packings are your problem

. . . pick the type with a plus!

You'll get many extra benefits from hydraulic operations when closer attention is given to this *plus factor:*

COMPATIBILITY between **P**ackings, **F**luids, **M**etals.

Over the years our engineers have been calling this the "P-F-M team". Every Houghton packing is made with this "team" in mind.

For a good reason, too. When packings, fluids and metals—all three—are *compatible,* hydraulic equipment serves you longer . . . maintenance is reduced . . . smooth, precision operation results.

It's a packing *plus* which the Houghton Man will be glad to discuss in more detail with you. He'll show you how standardizing on Houghton VIM and VIX-SYN Packings means:

Packings *right* for the job (we make all types and sizes)

Fluids compatible with their seals (both part of the team)

Metallurgical experience (we'll share a half-century of know-how with you)

A lot of this data is in books and bulletins we'll gladly send you on request. E. F. Houghton & Co., 303 W. Lehigh Ave., Philadelphia 33, Pa.

VIM and VIX-SYN PACKINGS

products of . . . E. F. HOUGHTON & CO.

PHILADELPHIA · CHICAGO · DETROIT · SAN FRANCISCO

Ready to give you on-the-job service . . .

magnesium

Lightweight Cabinet for Electronic Brains

...made of magnesium

Here's why you, too, should consider using Dow Magnesium—

- ★ It's *light in weight*, actually the lightest of all structural metals.
- ★ It has *high strength and rigidity* which permits simplifying your design for even further weight reduction.
- ★ *Excellent weldability* and ease of forming are just two of the many plus values in fabricating magnesium.

Now is the time to get complete details. From design to production is a long trip—take the first step with the *right metal!* Investigate magnesium. Complete engineering and fabricating facilities are available at Dow's Bay City Division as well as from other fabricators located throughout the country. THE DOW CHEMICAL COMPANY, Magnesium Sales Department MA 306B, Midland, Michigan.

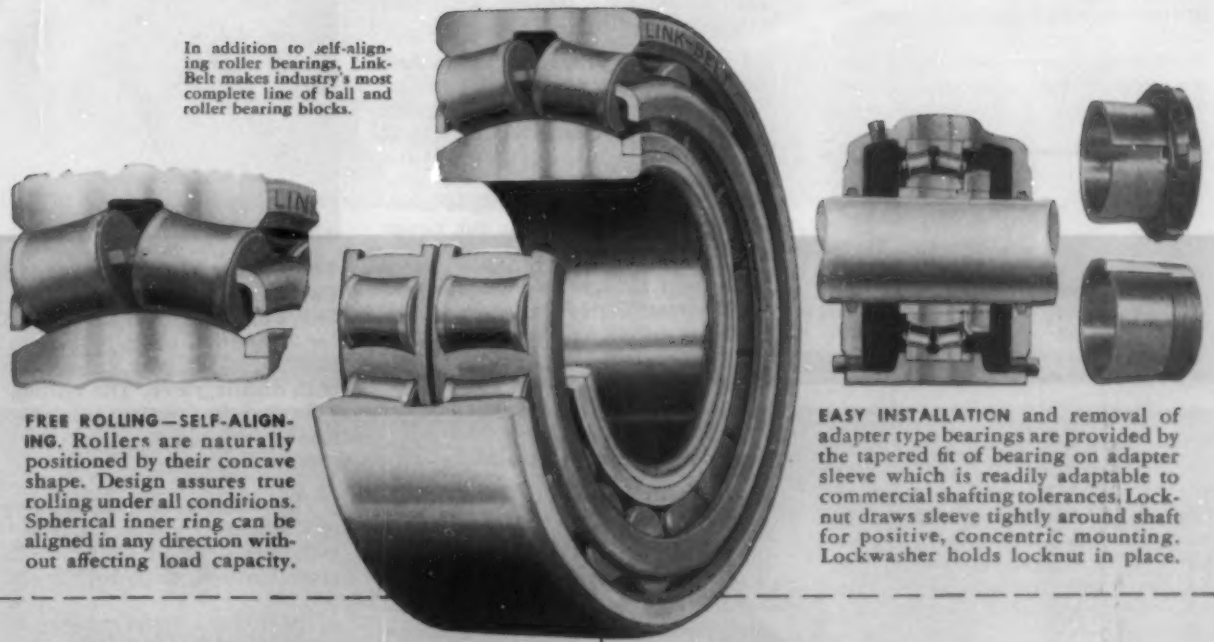
you can depend on DOW MAGNESIUM

DOW

For tough, heavy-duty applications... Make use of these important

bearing differences

In addition to self-aligning roller bearings, Link-Belt makes industry's most complete line of ball and roller bearing blocks.

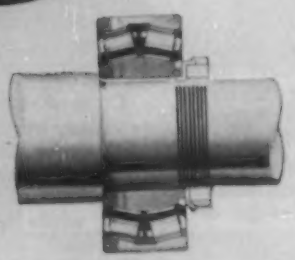


FREE ROLLING—SELF-ALIGNING. Rollers are naturally positioned by their concave shape. Design assures true rolling under all conditions. Spherical inner ring can be aligned in any direction without affecting load capacity.

EASY INSTALLATION and removal of adapter type bearings are provided by the tapered fit of bearing on adapter sleeve which is readily adaptable to commercial shafting tolerances. Locknut draws sleeve tightly around shaft for positive, concentric mounting. Lockwasher holds locknut in place.

LOCKED-IN CLEARANCE. Selective assembly of rollers and raceways with accurately formed hardened steel retainers assures proper operating clearance, guidance and spacing of rollers.

Rollers are completely pocketed in retainers for accurate spacing and guiding.



SMOOTH OPERATION, LONG LIFE are advantages of the straight bore type mounting, which assures maximum concentricity of inner ring with shaft. Especially desirable when minimum radial run-out is essential.

They're all present only in LINK-BELT self-aligning roller bearings

SUBTLE differences in bearings can make notable differences in the life and efficiency of your equipment. Take Link-Belt self-aligning roller bearings, for example. Their "self-contained" feature permits the bearing to float axially in the mounting, when desired, compensating for shaft expansion or settling of bearing supports . . . preventing extraneous thrust loads from being set up between bearings on the same shaft. What's more, inherent self-aligning design and preadjustment preclude use of expensive or cumbersome self-aligning housings.

Ask your nearest Link-Belt office for Book 2196 on self-aligning roller bearings and Book 2550, containing full data on all Link-Belt ball and roller bearings.

LINK-BELT

Ball and Roller Bearings

LINK-BELT COMPANY: Executive Offices, 307 N. Michigan Ave., Chicago 1. To Serve Industry There Are Link-Belt Plants, Sales Offices, Stock Carrying Factory Branch Stores and Distributors in All Principal Cities. Export Office, New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville, N.S.W.; South Africa, Springs. Representatives Throughout the World. 13,711

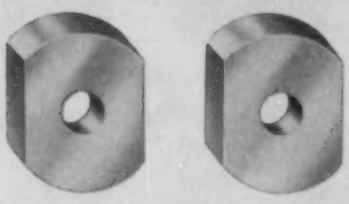
(*Advertisement*)

Carboloy Trends and Developments for Design Engineers...

How to select permanent magnet materials
How to use Thermistors as a circuit element
High-temperature testing with chrome carbide

Change of magnet material improves rotor performance

Outwardly, these two magneto rotors are exactly the same. But in performance, there is quite a difference.



Original rotor (left) was Alnico 5. Then Carboloy magnet engineers demonstrated that the flatter, more stable demagnetization curve of Carboloy® Alnico 6 would provide more coercive force and greater stability . . . without increasing cost. The new rotor is exactly the same size and shape – but 15-20% more effective.

In this case, Carboloy magnet engineers helped the manufacturer improve product performance through the use of a more suitable magnet material. Carboloy engineers can call upon their extensive knowledge of magnet materials to reduce product size and weight, simplify design, or lower costs.

Carboloy magnet engineers, aided by new measurement and development facilities, can also assist you in design and magnetic circuit analysis, and with the associated problems of magnetization, testing, demagnetization and stabilization. For more information, write, today, outlining your problem.

Thermistors simplify circuit design and lower costs

Heat practically any material, and its resistance *increases*. But heat a Carboloy Thermistor, and its resistance *decreases* tremendously.

For a temperature range from –50°C to 200°C, resistance of copper or platinum, for example, doubles. Over the same temperature range, resistance of Carboloy Thermistors decreases by a factor of 10,000.

With some Thermistors, it is possible to reduce resistance 50% with a temperature increase of 17°C.

Large temperature coefficients and other nonlinear characteristics make Thermistors ideal low-cost circuit elements for the measurement and control of minute temperature changes. These electronic semi-conductors eliminate costly, fragile components. They never wear out, never need maintenance.

To help designers evaluate the circuit possibilities of Thermistors, Carboloy offers engineering assistance, a 54-page Technical Manual, and several inexpensive Thermistor engineering kits. Write today.

Grade 608 Chrome Carbide remains stable at 1800°F

High temperature metals are frequently tested at temperatures in the range of 1800°F. But before performance can be measured accurately, engineers must have structural materials for their testing devices that can withstand such elevated temperatures.

Conventional metals and alloys rapidly become unstable above 1500°F. As temperature goes higher, there is a tremendous decrease in resistance to oxidation and creep. And, while ceramics can take the heat, they are too brittle for most tests.

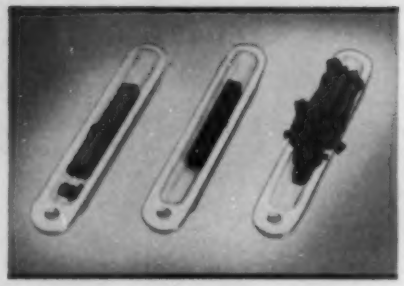
Today, however, test engineers are turning to a new structural material, Carboloy Grade 608 Chrome Carbide.

Chrome carbide combines all the requisites of high-temperature materials:

It retains strength at 1500°F or higher.

It resists oxidation at 1800°F or higher.

It resists creep and deformation at 1800°F or higher.



The photograph, above, demonstrates Carboloy Grade 608 Chrome Carbide's oxidation resistance at 1850°F, for 24 hours. At left, is 18-8 stainless steel; at right, tungsten carbide . . . both disintegrated. The chrome carbide in the center is untouched, except for a slight surface discoloration.

The transverse rupture strength of Carboloy Chrome Carbide is exactly the same at 1800°F as it is at room temperature – 100,000 psi.

These characteristics make chrome carbide ideal for load-applying members and sample grips for transverse rupture and tensile stress rupture testing, for anvil and Brale extensions, and for Brinell balls for hardness tests.

These same characteristics, plus chrome carbide's high abrasion resistance make it equally valuable for many wearproofing applications. For more information on the physical properties and applications of Carboloy Grade 608 Chrome Carbide, write today. A low-cost Grade 608 engineering appraisal kit is available.

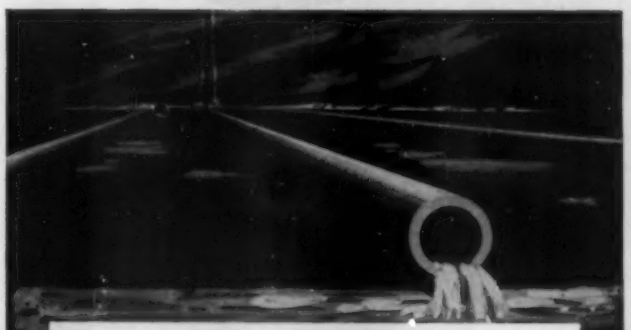
Permanent magnets, Thermistors and chrome carbides are but three of the Carboloy Created-Metals now helping designers improve products and lower costs. Others include: *cemented carbides* for combating wear, *Hevimet* for high-density and radioactive shielding applications, and *vacuum-melted metals*.

"Carboloy" is the trademark for products of the Carboloy Department of General Electric Company

CARBOLOY
DEPARTMENT OF GENERAL ELECTRIC COMPANY
11127 E. 8 Mile Ave., Detroit 32, Michigan

CARBOLOY CREATED-METALS FOR INDUSTRIAL PROGRESS

KRALASTIC Corrosion-Proof Pipe Makes Good in Many Fields!



SALT WATER DISPOSAL—Operating under 20" to 28" of vacuum at 110° F. in a Texas oil field, a 4100 ft. stretch of 4" KRALASTIC pipe is still going strong after two years. A previous installation of pipe lasted only 6 weeks.

OIL FLOW LINES—Carrying very corrosive sour crude, a 1200 ft. section of 3" KRALASTIC pipe has performed satisfactorily for more than 2½ years for a Texas oil company. Metal pipe previously used failed in only 4 months.

GAS LINES TO IRRIGATION PUMPS—In the Texas Panhandle rice growers have laid more than 225 miles of KRALASTIC pipe during the past 2½ years to convey the less expensive natural gas to irrigation pump engines. Freedom from corrosion, ease of use and speed of installation by unskilled labor all favor KRALASTIC pipe!

CHEMICAL PUMPING—for the past 1½ years a large chemical manufacturer has been transmitting 25% ammonium sulfate through 3000 ft. of corrosion-proof KRALASTIC pipe at a considerable saving over the cost of the rubber-lined steel pipe otherwise required.

KRALASTIC pipe is made from a unique combination of plastic and elastomeric materials. It is different both in composition and charactersitics from materials used in other types of plastic pipe.

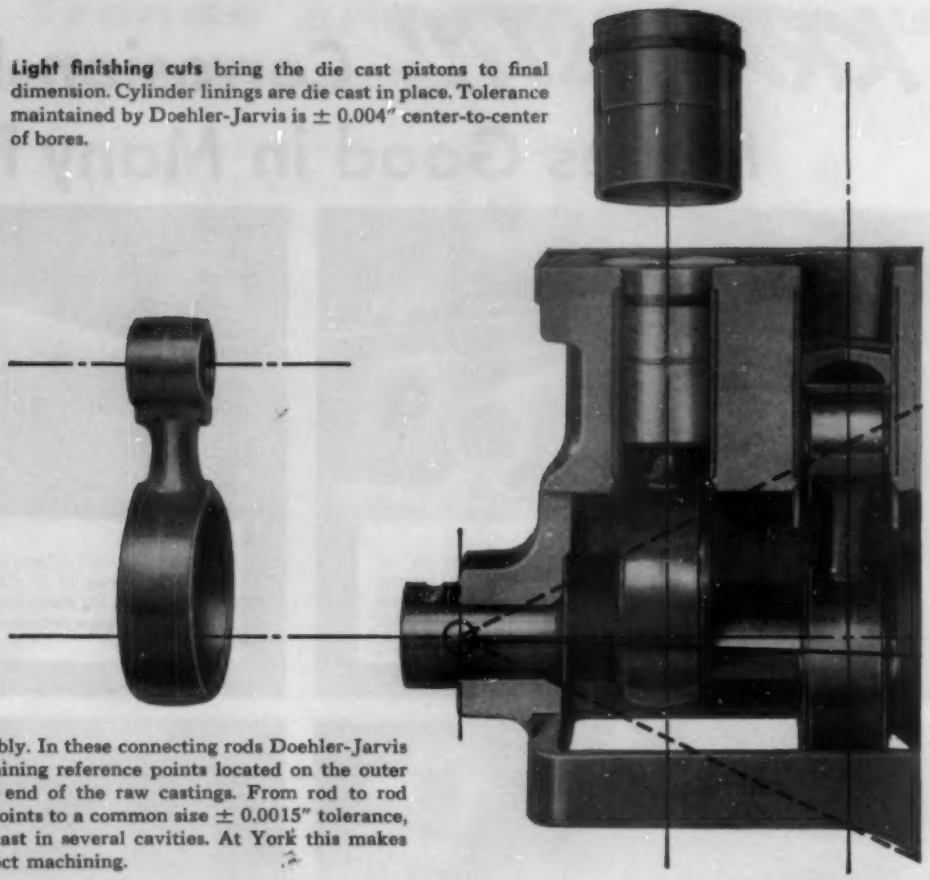
KRALASTIC produces pipe and pipe fittings that are both hard and tough, low in weight, high in tensile strength and unaffected by most chemicals that corrode metals.

Molders and extruders are finding KRALASTIC ideal for such products as combs; wheels; window channels; cases for small appliances such as hearing aids and electric shavers; housings for office and other types of machines, as well as for pipe. For further information on KRALASTIC, or for the names of the makers of KRALASTIC® pipe, write or phone us.

Naugatuck Chemical

Division of United States Rubber Company
Naugatuck, Connecticut

BRANCHES: Akron • Boston • Charlotte • Chicago • Los Angeles • Memphis • New York • Philadelphia • IN CANADA: Naugatuck Chemicals, Elmira, Ontario
Rubber Chemicals • Synthetic Rubber • Plastics • Agricultural Chemicals • Reclaimed Rubber • Latices • Cable Address: Rubexport, N.Y.



Light finishing cuts bring the die cast pistons to final dimension. Cylinder linings are die cast in place. Tolerance maintained by Doehler-Jarvis is ± 0.004" center-to-center of bores.

Cast-in chamfers aid assembly. In these connecting rods Doehler-Jarvis dies also establish two machining reference points located on the outer circumference of the throw end of the raw castings. From rod to rod Doehler-Jarvis holds these points to a common size ± 0.0015" tolerance, even though they must be cast in several cavities. At York this makes for smooth, precise, low-reject machining.

How Doehler-Jarvis helped York make hermetic compressors lighter and

This is a story of practical product engineering.

Its concern is with things you may want for your product. Reduced size, weight, cost. Stepped up efficiency. Increased life. These were what York Corporation wanted for its post-war "packaged" air conditioners.

And at war's end, York was ready with a revolutionary, new hermetic compressor design. Small, simple, efficient. Aluminum for lightness. Now . . . how should it be made?

Cool! Light, small die cast compressors make York Window Conditioners compact, efficient and good for years of trouble-free service.

Three cost factors favor die casting

1. Raw castings cost less (less metal to buy)
2. Less machining was needed (less waste, fewer man-hours)
3. Tooling requirements were lower (fewer tools, lighter and less costly)

With these factors in mind, York took their two-cylinder, ¾ H.P. compressor* as a starter and went into production. Within a few years their whole line was converted to the new die cast design. Later . . .

York sees a way to cut size and weight even more

Doehler-Jarvis was asked to incorporate compressor and motor housing into a one-piece die cast unit. A series of conferences followed.

Together, engineers from both companies solved one problem after another. Precise dimensional control. Cast-in-place cylinder linings. Die cast bearing surfaces. Concentricity and precise location of cylinder center lines. (To solve this one, Doehler-Jarvis had to provide in the

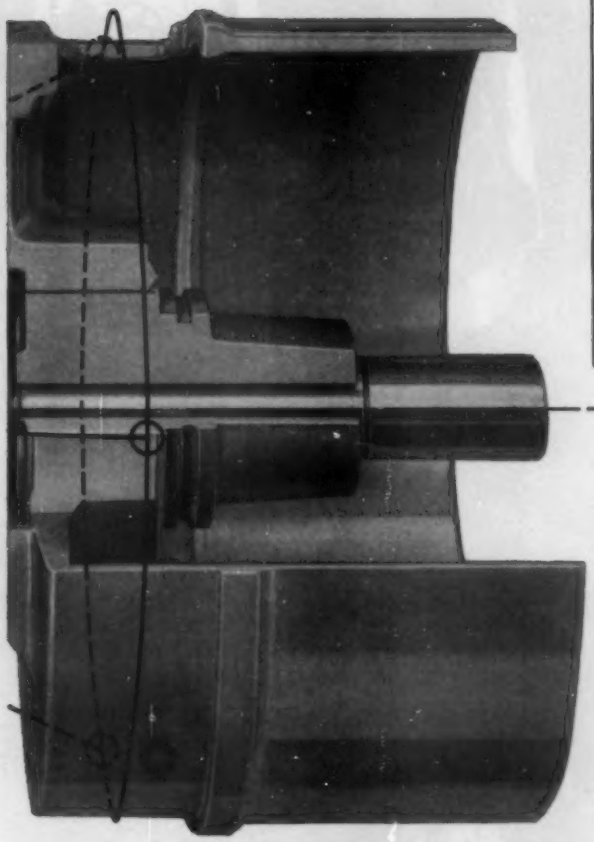
**Test units, run continuously ever since, have logged over 70,000 hours without failure.*

"Phantom" control cone, with three "no tolerance" chucking surfaces, establishes precision

In the raw casting three equidistant chucking surfaces are established by the Doehler-Jarvis die. Their centers are located on a circle concentric with and exactly perpendicular to the shaft. The plane thus established forms the base of a "phantom" control cone (see illustration) whose apex is at the small bearing bore.

From this cone as a reference, all center lines and true surfaces throughout the piece are established. All machining setups, too, are based upon it.

At the Doehler-Jarvis plant, great care is taken to hold the chucking surfaces true. Aside from very slight variations in cooling, no tolerance is allowed. As a result, York machining proceeds smoothly with minimum rejects at every stage. What's more, the resulting precision insures long wearing bearings, long life pistons and cylinders.



more compact through die casting

die for three "no-tolerance" chucking surfaces on the raw casting . . . precisely located with respect to the front bearing bore.)

This expert product engineering team went on to develop for other sizes other integrated die cast housings, and the connecting rods, pistons, main bearings, and oil slinger rings. These compressors are light, compact and highly efficient. They can be produced quickly and easily.

"Cannot be matched for low cost," York says

"What's more, because the parts can be die cast in a hurry . . . and because Doehler-Jarvis never fails us on delivery . . . we stay flexible. We're able to meet peak demands for air conditioners without going overboard on finished inventory."

Come back to the things you want to do for your own product . . . maybe Doehler-Jarvis could help you do them with die castings. We've done it for scores of manufacturers, large and small—including makers of home appliances, office and public utilities equipment, industrial machines, and many other similar products made better with die castings.

So, if you are engineering a new product or improving the one you have, call in Doehler-Jarvis. With more than fifty years experience behind us, we may be able to contribute in many ways.

Doehler-Jarvis Division

of

National Lead Company

General Offices: Toledo 1, Ohio

FLEXLOC AT WORK

Power Hack Saw Builder Fastens blade guides with FLEXLOC self-locking nuts. Eight of these one-piece, all-metal locknuts are used in this assembly. And they won't work loose, regardless of vibration.

You can get the same dependable service. FLEXLOCS come in a wide range of sizes, types and materials. They are stocked by leading industrial distributors everywhere. Ask your local man for Bulletin 866. Or write STANDARD PRESSED STEEL CO., Jenkintown 28, Pa.

• • •

Use FLEXLOCs anywhere:

ON ROUGH BOLTS. FLEXLOCS smooth out bolt threads without damaging their own threads.

IN TEMPERATURES TO 550° F. in plated nuts and even higher in unplated ones. High temperatures do not affect FLEXLOCS. Nuts with non-metallic inserts fail under such conditions.

AS LOCK OR STOP NUTS. After at least 1½ threads of a standard bolt are past the top of the nut, the FLEXLOC stays put.

REGARDLESS OF MOISTURE, OIL, DIRT AND GRIT. Even conditions like these do not affect the locking ability of FLEXLOCS.

FLEXLOC®
LOCKNUT DIVISION
sps
JENKINTOWN PENNSYLVANIA

At last!

SPLIT V-RING PACKING

that's really LEAKPROOF!

LINEAR VEE-DAM RINGS

Labyrinth flow and lateral leakage are stopped by LINEAR'S uniquely designed, revolutionary VEE-DAM RINGS. Installation of these trouble-saving, long-lasting packings is virtually foolproof!

A STURDY RUBBER DAMS

faced in opposite directions in the grooved hinge area of each ring, hermetically seal off center groove sections when LINEAR VEE-DAM Rings are stacked together . . . eliminating all labyrinth flow.

B EXTERNAL ABUTMENTS

on the outside shoulder edge of the ring, staggered in relation to the internal dams, prevent lateral leakage, and provide stabilizing support.

U. S. Patent No. 2,665,151

LINEAR VEE-DAM Rings save on installation time because they don't require precise fitting. They provide a perfect seal with minimum gland load, giving lower friction against the ram and far longer life than ordinary packing.

Write or call for complete information on LINEAR *VEE-DAM Rings in a choice of rugged, fabric-reinforced synthetic elastomers, tailored to your requirements.*

"PERFECTLY ENGINEERED PACKINGS"

LINEAR

LINEAR, Inc., STATE ROAD & LEVICK ST., PHILA. 35, PA.

From the collection of Lewis Winant, New Jersey Arms Collectors Club. Maker: Wogdon, London, 1786-1787. An 11-by-14 inch print of this illustration will be sent free when requested on company letterhead.

challenge accepted

When this booster rotor, an artillery fuse component, was offered for production to the powder-metallurgy industry, Bound Brook was among those who were quick to accept the challenge. Initially, the part had been produced by machining brass bar stock, a method which proved to be both excessively costly and discouragingly slow. Powder metallurgy fabrication looked simple enough at first, until the critical weight and dimension factors were examined more closely—for in artillery fusing the difference between a hit and a dud can depend on a thousandth of an inch. By mustering all of its know how, accumulated in more than 30 years of producing metal-powder parts, Bound Brook emerged as the major producer of this rotor—at a cost nearly 40% less than was required for conventional machining.

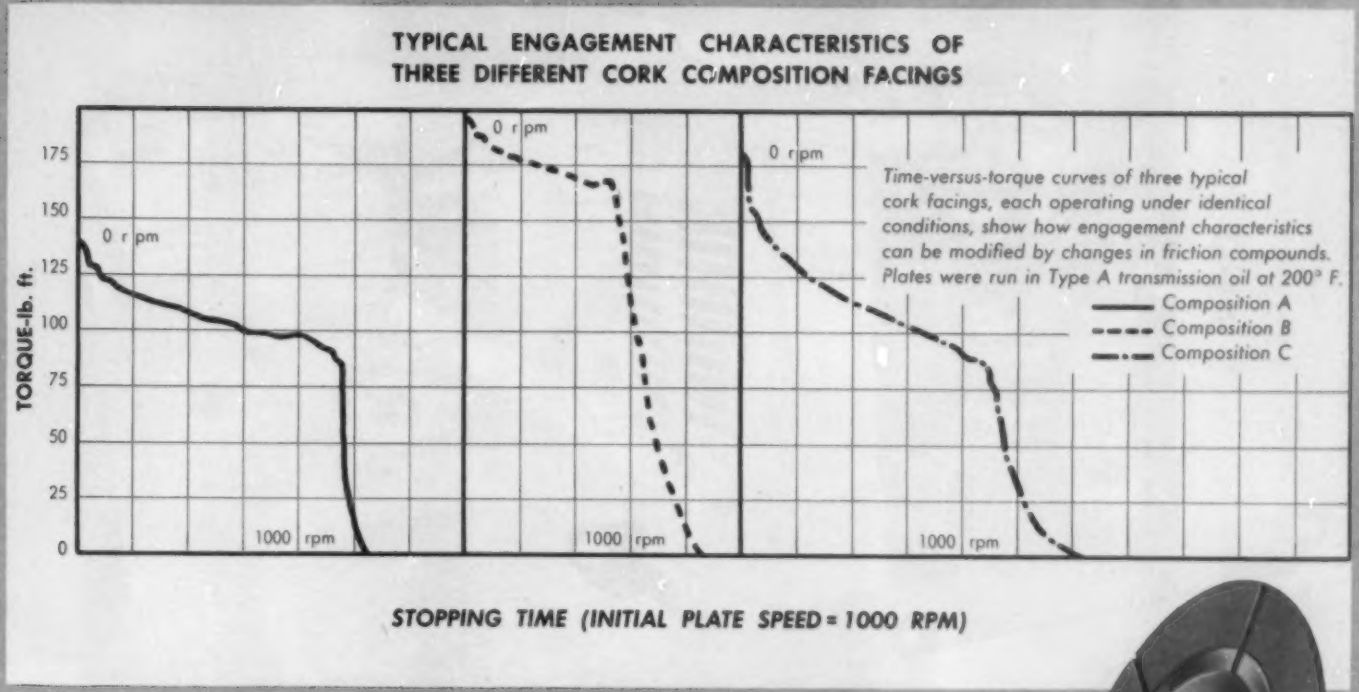
10

BOUND BROOK

BOUND BROOK OIL-LESS BEARING CO., EST. 1883, BOUND BROOK, N. J.

Pioneer in

POWDER METALLURGY BEARINGS + PARTS



CORK CLUTCH FACINGS:

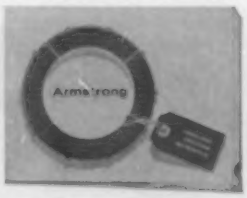
How engagement characteristics can be controlled by modifying the facing compound

The chart above shows how engagement characteristics of clutches can be modified by slight changes in the cork compound used as a facing. The three test plates were run under identical conditions, but with a different material on each plate.

As these curves indicate, you can expect a marked difference in the type of engagement that each material will produce in a given clutch. This is typical of the wide range of performance characteristics that can be gained through proper compounding of cork friction materials. This unusual versatility makes cork facings adaptable to the varying demands of different mechanical systems.

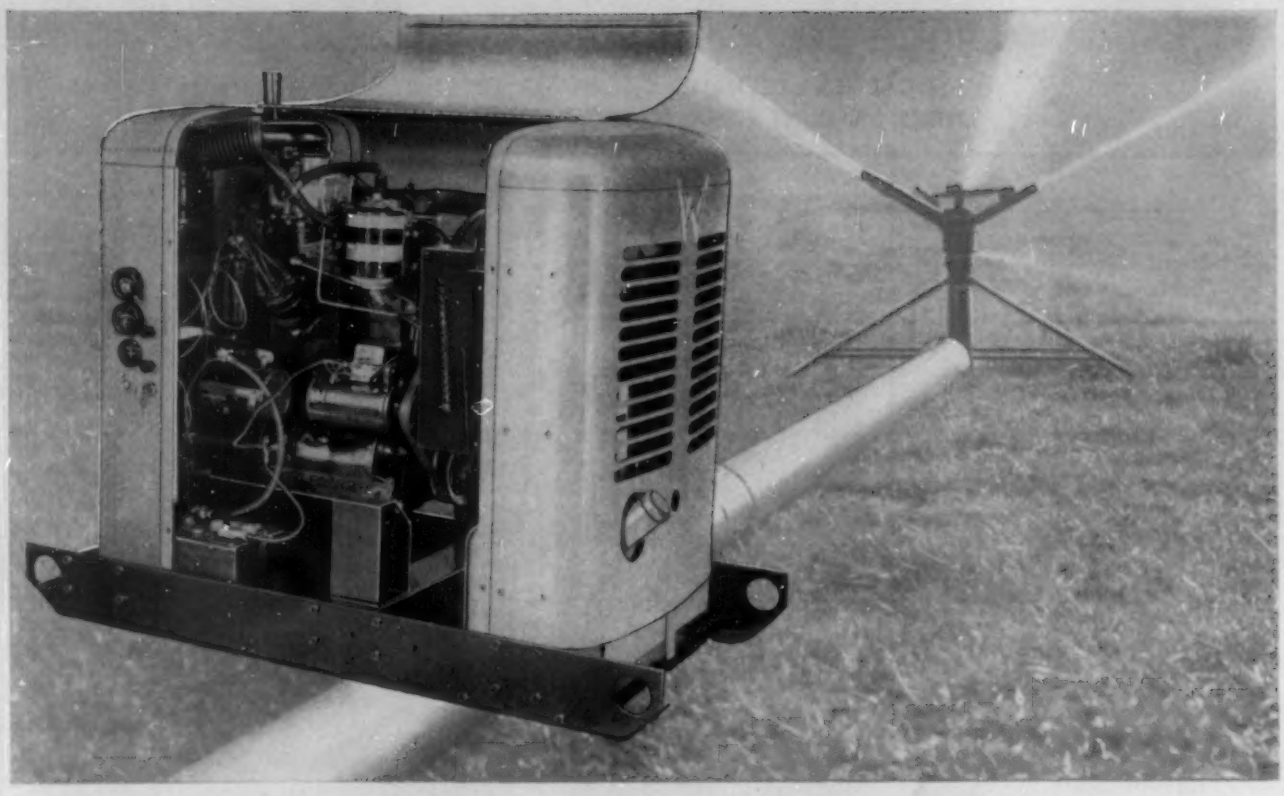
Cork clutch facings can be made using a variety of resins and rubbers as binders. Precise variations in the kind and amount of binder result in many possible compounds, each differing somewhat in torque capacity, rate of engagement, and degree of slip. Within this wide range of performance characteristics, you can choose an engagement that is smooth and shock-free, or one that is virtually instantaneous, depending on the needs of your particular design.

For more information on the performance versatility of cork-compound friction materials, send for a copy of "Armstrong Resilient Friction Materials." Write on your letterhead to Armstrong Cork Company, Industrial Division, 7206 Irvin Street, Lancaster, Pennsylvania.



Armstrong FRICTION MATERIALS

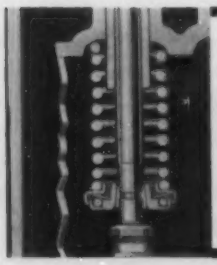
. . . used wherever performance counts



'Jeep' ENGINE RUGGEDNESS...

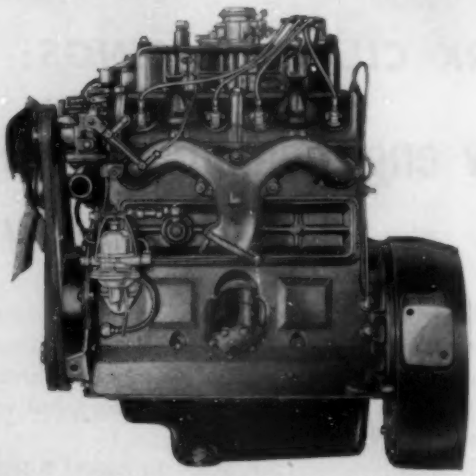
Steady Thunder that Pounds out Rain

Steady does it in irrigation. That's why **proven-in-action** 'Jeep' engine features designed into 4 or 6 cylinder POWER GIANT Industrial Engines have scored high with farmers when these durable engines have powered their irrigation pumps. Wherever constant, dependable service is a **must**, POWER GIANT Engines are in demand. Complete Willys Power Units are available, or engines can be installed directly into your equipment. Write today for technical bulletins.



POSITIVE Valve Rotators

Hard-faced, nickel chrome alloy steel valves in POWER GIANT Engines are equipped with Positive Rotators to increase valve life, and minimize carbon hazard to engine life. Valve turns with each opening, ejecting carbon and keeping valve seats and stems clean and workable. Just one more 'Jeep' engine feature for rugged staying power.

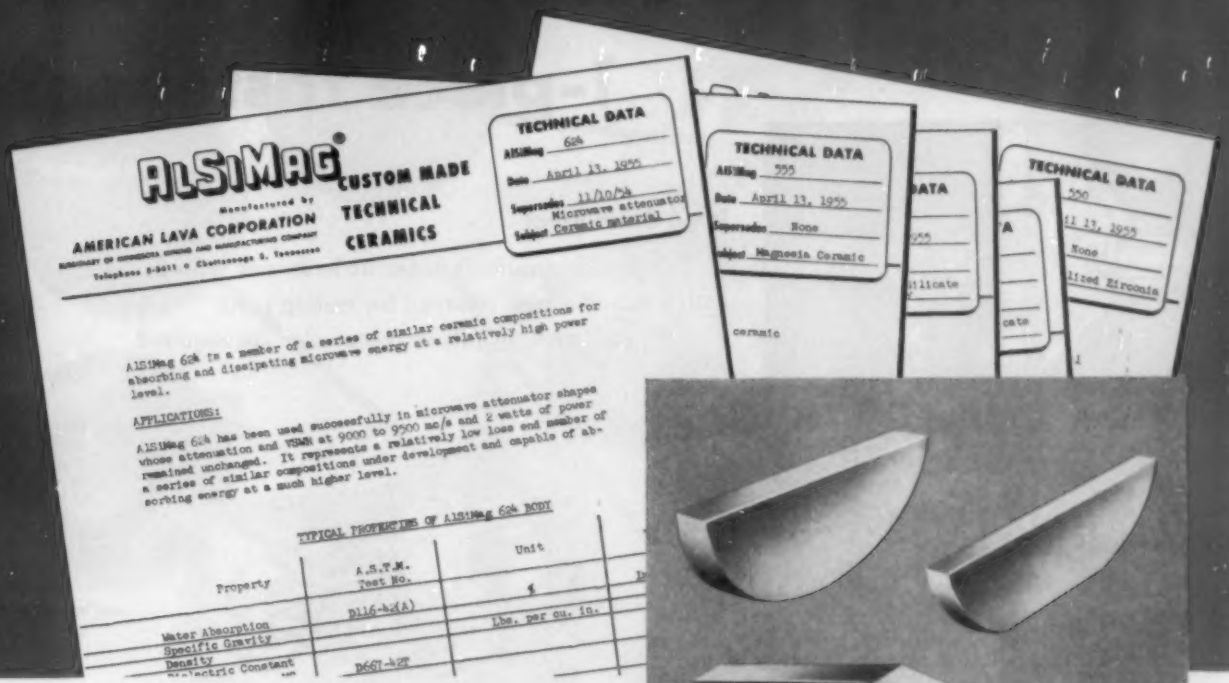


Model Range	JEEP (L-4)	HURRICANE (F-4)	LIGHTNING (L-6)
Max. bhp	22-60	22-70	28-75
Range of Speed	1200-4000	1200-4000	1200-4000

'Jeep' **POWER GIANT** Industrial Engines and Power Units

WILLYS MOTORS, INC. • *Industrial Engine Department*

1455 NORTH COVE BLVD. TOLEDO, OHIO


ALSIMAG®
CUSTOM MADE TECHNICAL CERAMICS
AMERICAN LAVA CORPORATION
TECHNICAL DATA
AlSiMag 624
Date April 13, 1955
Supersedes 11/10/54
Subject Ceramic material
AlSiMag 624 is a member of a series of similar ceramic compositions for absorbing and dissipating microwave energy at a relatively high power level.
APPLICATIONS:
AlSiMag 624 has been used successfully in microwave attenuator shapes whose attenuation and VSWR at 9000 to 9500 mc/s and 2 watts of power remained unchanged. It represents a relatively low loss end member of a series of similar compositions under development and capable of absorbing energy at a much higher level.
TYPICAL PROPERTIES OF AlSiMag 624 BODY
Property
A.S.T.M. Test No.
Unit
Water Absorption
Specific Gravity
Density
lbs. per cu. in.
D116-42(A)
D667-42T
TECHNICAL DATA
AlSiMag 555
Date April 13, 1955
Supersedes None
Subject Magnesia Ceramic
ceramic
TECHNICAL DATA
None
Fired Zirconia

TEST SAMPLES CAN BE MADE TO YOUR SPECIFICATIONS AT REASONABLE COST

ALSIMAG®

SPECIAL PURPOSE CERAMIC MATERIALS

Most of our customers find the exact ceramic for their needs on property chart No. 551. This handy chart (sent free on request) gives mechanical and electrical data on the most frequently used AlSiMag materials. But this is by no means the full selection. AlSiMag offers the widest choice of ceramic materials in the industry. It isn't practical to list them all on one chart.

If you need a ceramic with unusual characteristics, tell us your requirements. We'll be glad to send you specification sheets (like those shown above) on the special purpose AlSiMag material that most nearly fills the bill. If we don't have the right material, perhaps we can develop one. Laboratory records from over 50 years of specialized experience often enable us to produce promptly a new composition "tailor made" for your needs.

Remember, the right ceramic can make all the difference in your product's performance. And, the best source for the right special purpose ceramic is AMERICAN LAVA CORPORATION. Write us today for detailed information on your requirements.

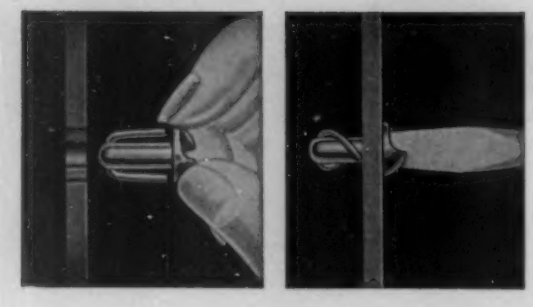
54TH YEAR OF CERAMIC LEADERSHIP

AMERICAN LAVA CORPORATION

CHATTANOOGA 5, TENNESSEE
A Subsidiary of
Minnesota Mining and Manufacturing Company

Branch offices in these cities (see your local telephone directory): Cambridge, Mass. • Chicago, Ill. • Cleveland, Ohio • Dallas-Houston, Texas • Indianapolis, Ind. • Los Angeles, Calif. • Newark N. J. • Philadelphia-Pittsburgh, Pa. • St. Louis, Mo. • South San Francisco, Calif. • Syracuse, N. Y. • Tulsa, Okla.
Canada: Irvington Varnish & Insulator Div. Minnesota Mining & Mfg. of Canada, Ltd., 1390 Burlington Street East, Hamilton Ontario, Phone Liberty 4-5735.

Have you a similar use for this 1-piece fastener?

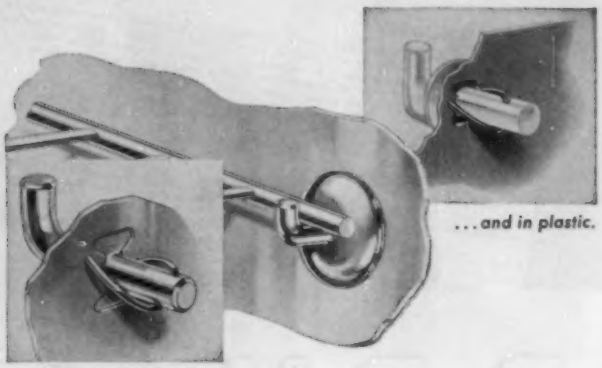


It's a Blind Rivet

...Or a removable fastener. It locks and unlocks with a 90° clockwise rotation. No mating parts such as nuts or receptacles are required.

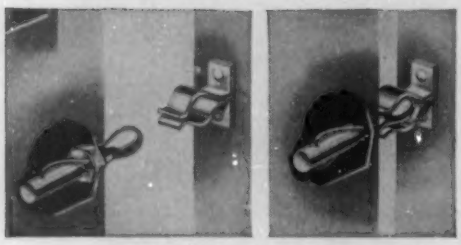
It's a Shelf Support

...For ranges or refrigerators—in plastic and metal. Leading appliance makers have achieved substantial installation savings through its use.



...and in plastic.

Both in metal...

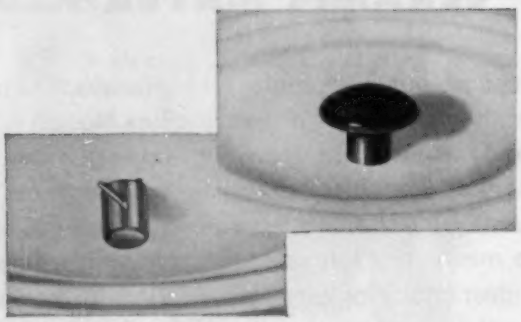


It's a Cabinet Door Strike

...Simple to install; eliminates welding and cuts assembly cost. Any head can be designed without affecting fastening principle.

It's a Lifter Knob or Dashboard Plug

...Plastic Spring-Lock heads are molded around steel inserts, giving strength at point of load or impact. Any shape head can be molded in any color.



What's Your Application?

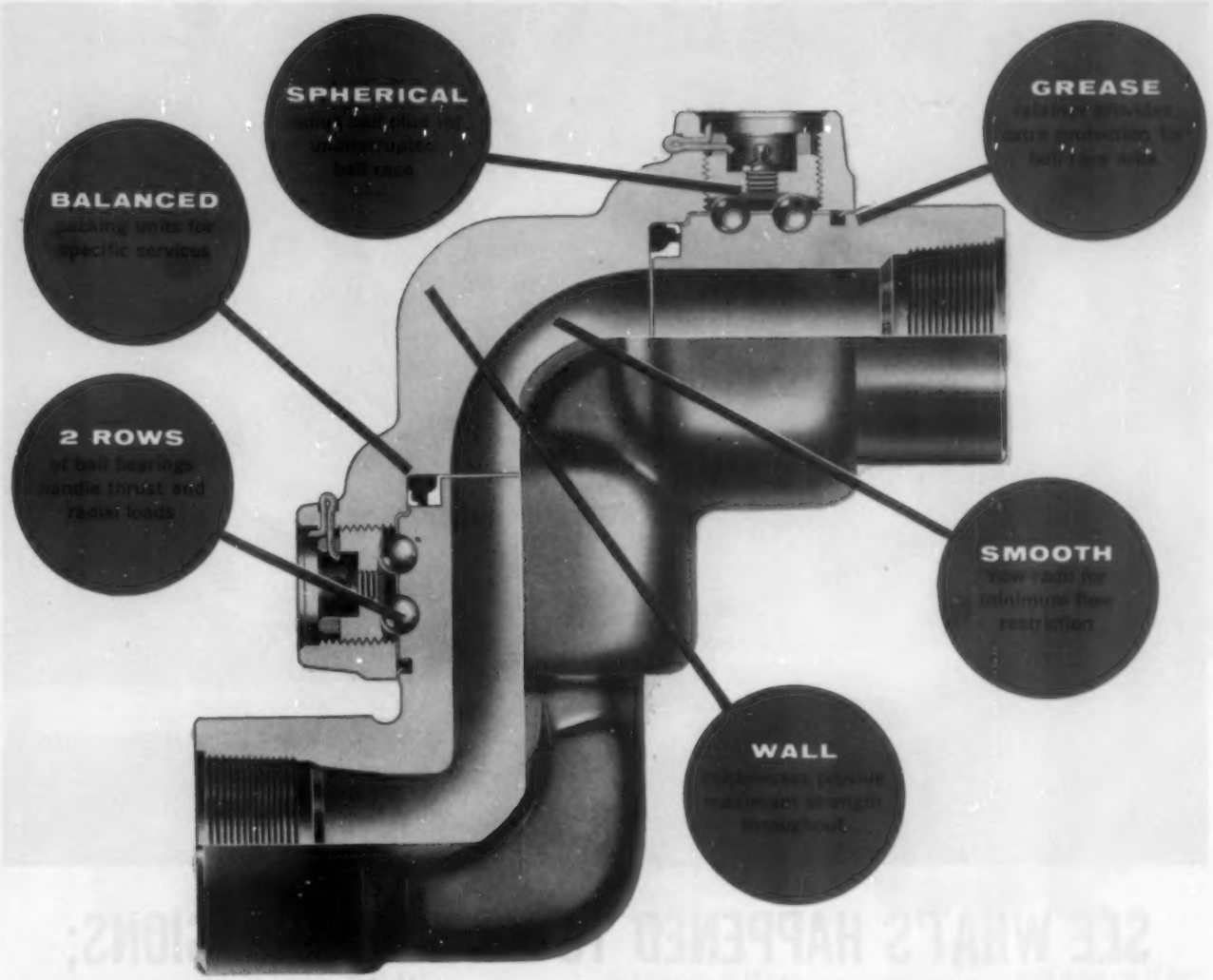
...Tell us how you can use Spring-Lock Fasteners in your products. We'll be glad to work out the details with you.

Simmons

QUICK-LOCK
SPRING-LOCK
ROTO-LOCK
LINK-LOCK
DUAL-LOCK

JUST OUT!
NEW 36-PAGE CATALOG WITH APPLICATIONS
SEND FOR IT!

SIMMONS FASTENER CORPORATION
1751 NORTH BROADWAY, ALBANY 1, N. Y.



precision engineered for your service

CHIKSAN Ball-Bearing Swivel Joints are precision engineered like a fine watch to give unlimited flexibility and unlimited service in the conduct of fluids, gases and liquids.

CHIKSAN is the originator and largest exclusive manufacturer of ball-bearing swivel joints in the world today.

CHIKSAN produces packing designs for specific service requirements, assuring constant torque at any given pressure.

CHIKSAN has acquired a world-wide recognition for highest quality of product and lowest maintenance costs.

CHIKSAN has over a quarter of a century of "know-how" in the design, manufacture and successful scientific application of ball-bearing swivel joints in industry.

CHIKSAN offers the widest range of styles, sizes and pressures available for every major industrial use today.

CHIKSAN has complete nation-wide coverage of its products and applications by qualified field service engineers.

CHIKSAN will custom engineer for you the solution to any problems involving the transport of fluids, gases and liquids.

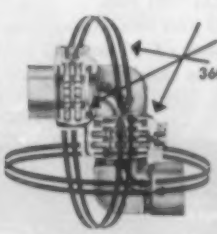
Write CHIKSAN for latest INDUSTRIAL CATALOG—G-4 Dept. PE-6

Supply and Service of CHIKSAN Ball-Bearing Swivel Joints is always as near as your telephone.

The Flow of Enterprise Relies on

CHIKSAN

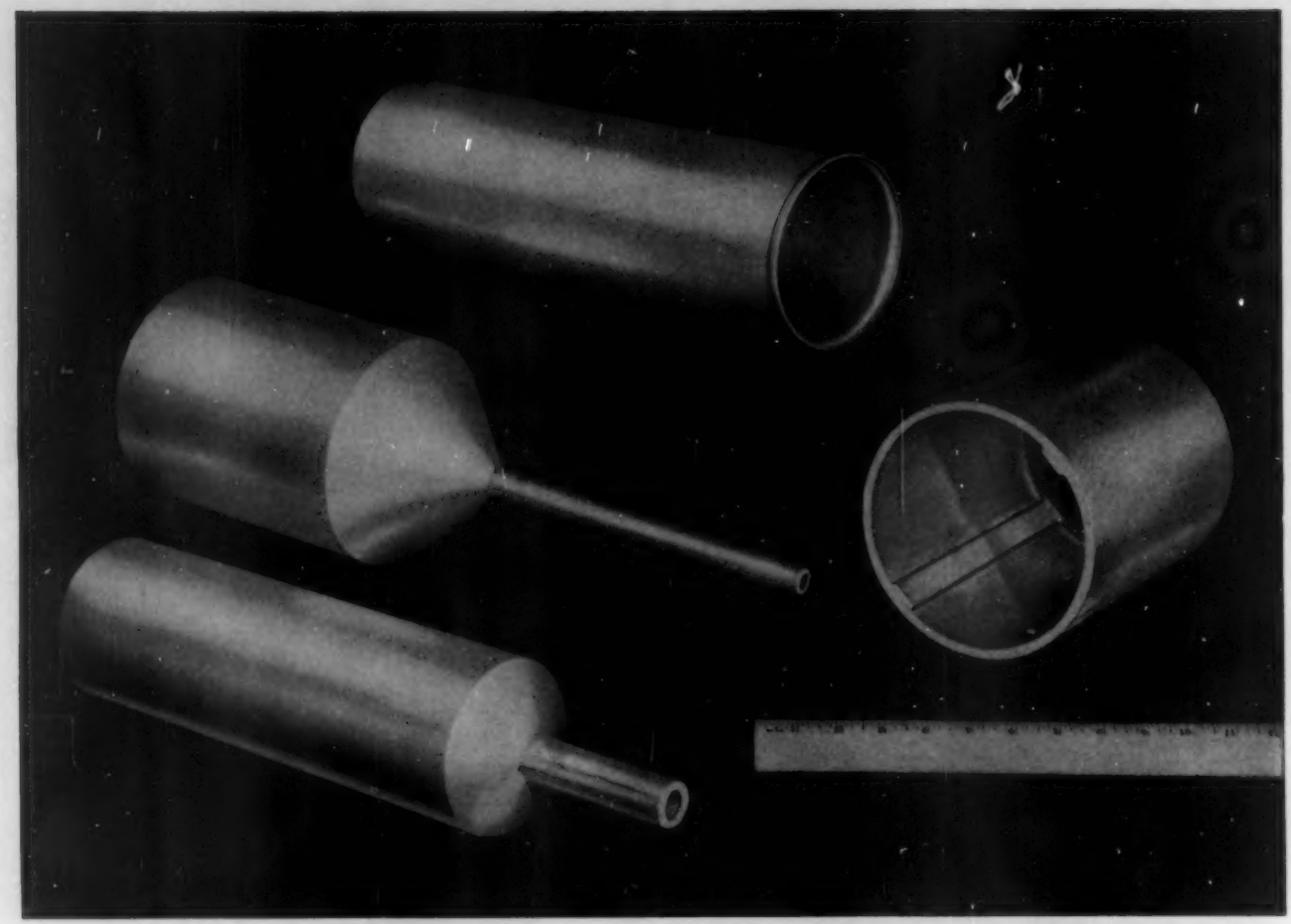
Ball-Bearing Swivel Joints



CHIKSAN Ball Bearing Swivel Joints are THE NEW TOOL of Modern Industry with full 360° rotation in 1, 2, and 3 planes. Over 1,000 different types, styles, and sizes have been developed for pressures and services from 28" vacuum to 15,000 psi and for temperature ranges from minus 70° to a plus 500° F. with packing materials for each specific service.

CHIKSAN COMPANY • BREA, CALIFORNIA • Chicago 3, Illinois • Newark 2, New Jersey

Well Equipment Mfg. Corp. (Division), Houston 1, Texas • Subsidiaries: Chiksan Export Co., Brea, Calif.; Newark 2, N. J. • Chiksan of Canada Ltd., Edmonton, Alta.



SEE WHAT'S HAPPENED TO IMPACT EXTRUSIONS; ALCOA CAN MAKE THEM BIGGER AND STRONGER

(and with more complex design details than ever before)

People who think of aluminum impact extrusions only in terms of tooth-paste tubes are in for a shock these days. Hydraulic cylinders for jet aircraft are Alcoa Impacts. Complete electric motor housings are Alcoa Impacts. Parts as long as 18 inches, parts weighing up to 10 pounds are now made as Alcoa Impacts.

In the thousands of production applications where Alcoa Impacts are practical, they offer special advantages over other forms of fabrication. Lighter than a forging, stronger than a machined part, sounder than a casting, faster than weldment . . . and part for part, Alcoa Impacts cost less.

These days you can expect tensiles up to 75,000 psi, surface finishes of 40 to 250 microinches, length-to-diameter ratios as high as 12 to 1.

Where can you use Alcoa Impacts? Your local Alcoa sales engineer represents Alcoa's complete impact extruding facilities, and will be happy to help you investigate the many cost-saving design possibilities which Alcoa Impacts offer. For complete design information, write Aluminum Company of America, 1992-F Alcoa Bldg., Mellon Square, Pittsburgh 19, Pa.

Your Guide to Aluminum Value

ALCOA ALUMINUM

ALUMINUM COMPANY OF AMERICA

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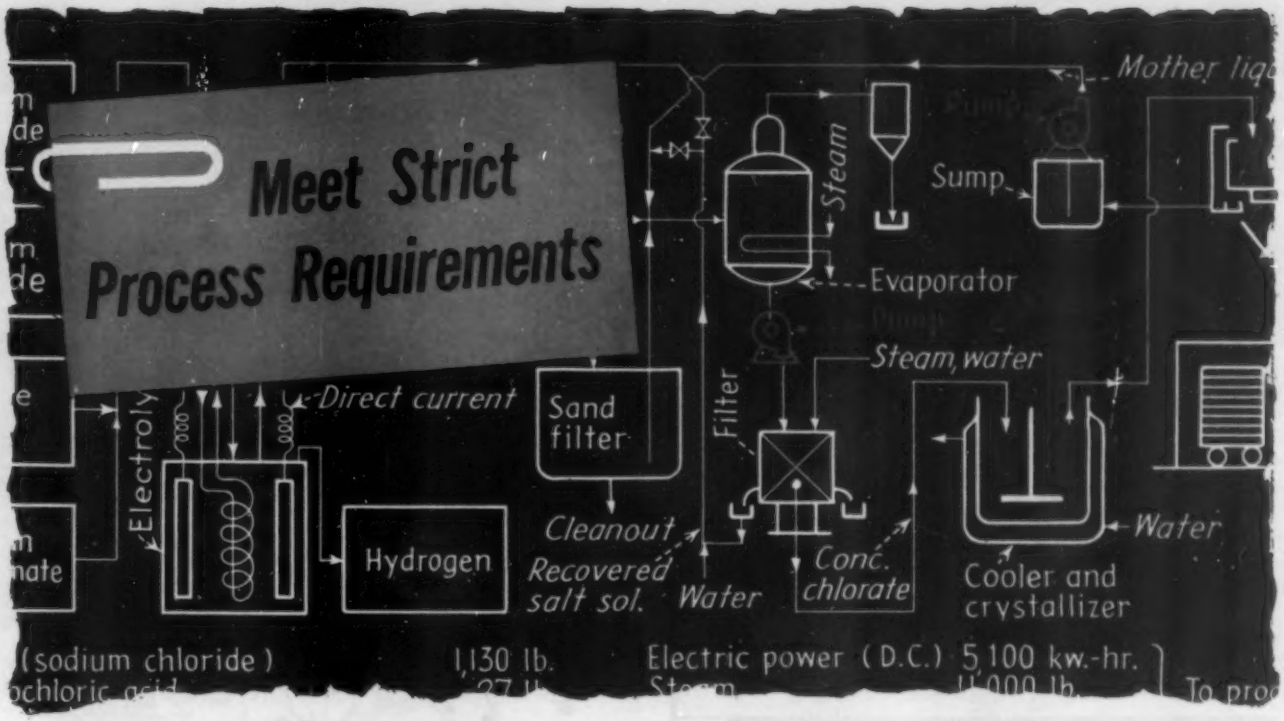
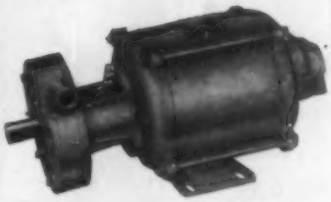
Fasten Aluminum With Alcoa® Aluminum Fasteners

Alcoa Makes Impact Extrusions to Your Specifications



. . . with Eastern Centrifugal Pumps

Models 2F and 2J
to 2 g.p.m., 25-42 p.s.i.



Model D-11
to 7.5 g.p.m., to 18 p.s.i.

Model F
to 17 g.p.m., to 17 p.s.i.

Models U-17 and U-34
to 38 g.p.m., to 21 p.s.i.

Models W and Z
to 70 g.p.m., to 11 p.s.i.

Models 3F and 3J
to 5 g.p.m., 29-65 p.s.i.

Recent redesign of these close-coupled Centrifugal Pumps has gained tremendous ruggedness and allowed for a wide selection of power requirements. In every detail of size, weight, space requirements, power, and costs, Eastern pumps fill the bill for strict process standards.

Six standard models range from 1/8th to 3/4 H.P., with capacities up to 70 G.P.M., pressures to 65 P.S.I. Eastern Centrifugal Pumps are available in Cast Iron, Bronze, Stainless Steel, Monel, and Hastelloy "C".

Eastern's engineering service offers many special models to meet your specific needs as to capacity and construction. Recommendations entail no obligation, and your inquiries are invited.

NEW EASTERN CATALOG

Eastern Centrifugal Pump Catalog contains engineering data, performance charts, diagrams and helpful general information. Request Bulletin 110B.

Eastern
INDUSTRIES, INC.
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Are you taking advantage of our SERVICE COVERAGE?

Leading manufacturers in both wood and metal are currently using our custom finish recommendations and our materials in the areas shown on the map.

Our service network has already been established to serve these customers with prompt shipments and technical assistance. If you are located in this neighborhood, you are invited to enjoy the advantages of our service coverage.

The Better the Finish, the Better the Buy

GRAND RAPIDS VARNISH CORPORATION

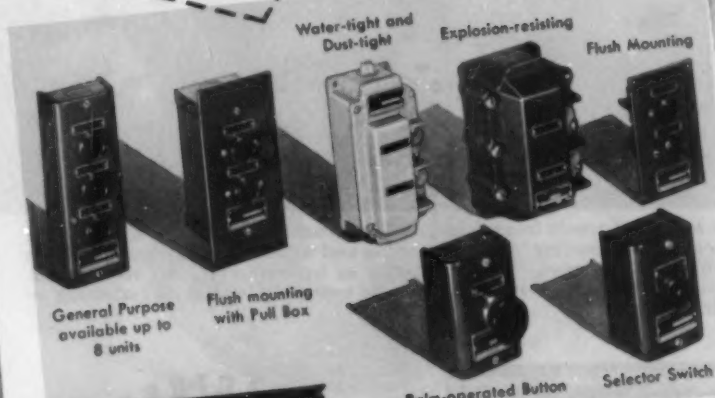
MAKERS OF THE FAMOUS Guardsman® *FINISH AND* Guardsman® *CLEANING POLISH*

GRAND RAPIDS, MICHIGAN

THIS COMPLETE LINE MEETS EVERY NEED FOR PUSHBUTTONS

DESIGN LEADERSHIP

STANDARD DUTY



HEAVY DUTY

Name your pushbutton requirement—there's a Square D unit to do the job, exactly. Three complete lines . . . standard duty, heavy duty, and oil-tight heavy duty . . . each providing a wide range of operators, stations, and circuit combinations.

OIL-TIGHT HEAVY DUTY

Available in 1 to 16 unit sizes. 6-9-12-16 unit stations have hinged covers for easier wiring

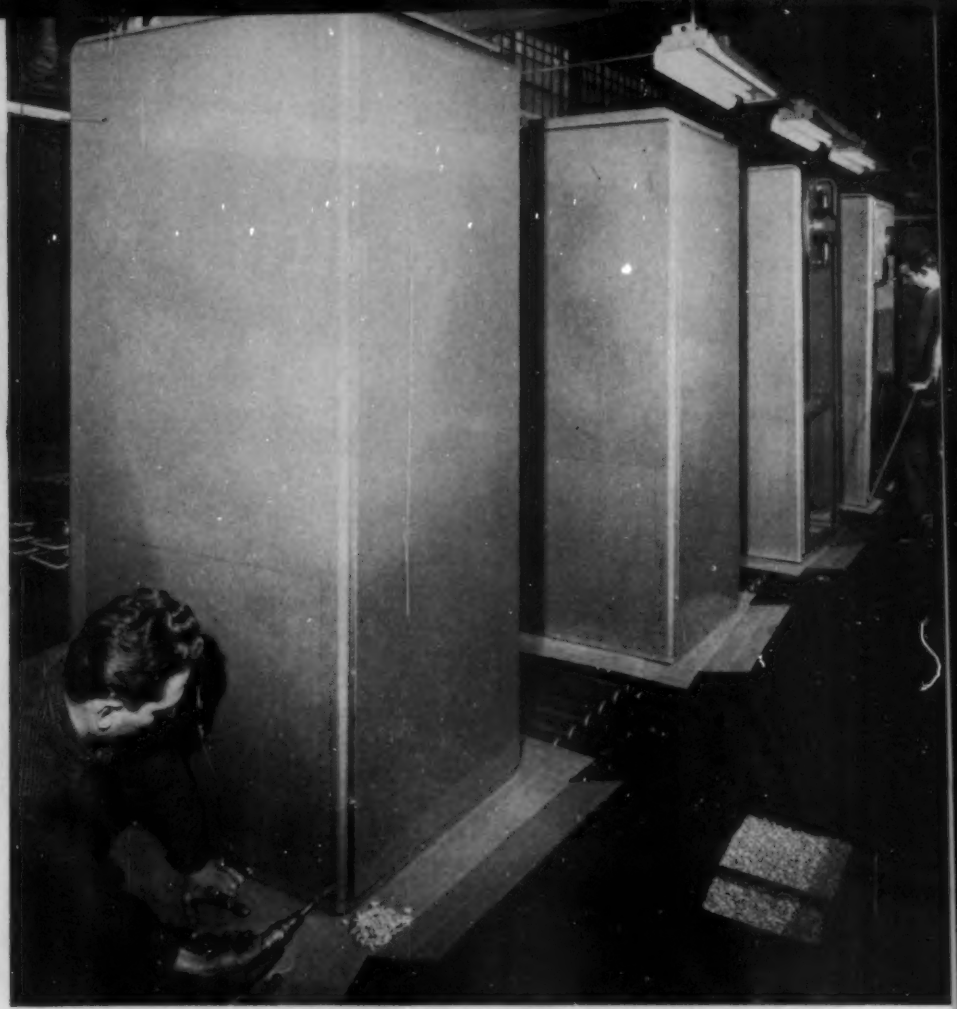
Write for Pushbutton Bulletins which give complete details. Address Square D Company, 4041 N. Richards Street, Milwaukee 12, Wisconsin.

ASK YOUR ELECTRICAL DISTRIBUTOR FOR SQUARE D PRODUCTS

SQUARE D COMPANY

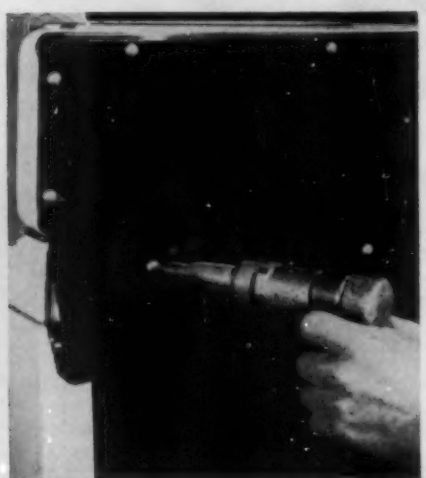
RESULTS SHOW IMPROVED PRODUCTION

...with Phillips
Cross-Recessed-Head Screws



ASSEMBLY LINE MIRACLES result from using Phillips cross-recessed-head screws in *all* Bryant Heater plants on heating, air conditioning and water heating units. Bryant's general assembly director says, "In all exterior or interior applications it is important that we use screws that incorporate easy assembly with rigid fastening — that means Phillips."

QUICK, EASY INSTALLATION applies equally to Fleetlite — "America's FINEST Windows" — and to the Phillips cross-recessed-head screws which assure sturdy, rigid, long-lasting *precision* construction. Says plant manager of Fleet of America, Inc., maker of these windows, "Phillips screws complement the high standards of our extruded aluminum construction. We use them exclusively."



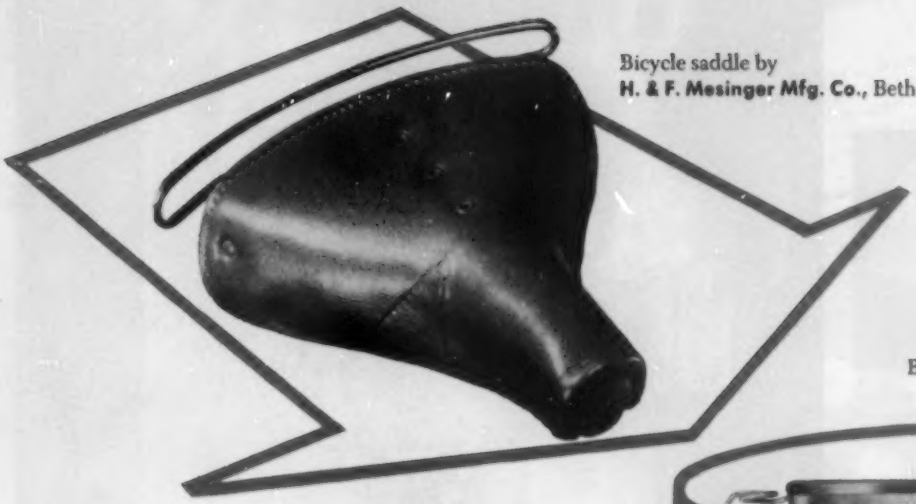
"NEATER APPEARING RANGE through the design of the Phillips screw head," says Assistant Superintendent of Tappan Stove Co., Mansfield, Ohio, founded 1881. "In addition, these screws improve production, speed assembly — and offer several safety factors. They have gained the approval of the men who use them."

• MANUFACTURERS OF • PHILLIPS CROSS-RECESSED-HEAD SCREWS

THE FASTENERS OF TODAY... AND OF THE FUTURE

X marks the spot
... the mark of extra quality

Allmetal Screw Products Company, Inc. • American Screw Company • Atlantic Screw Works, Inc. • The Blake & Johnson Co. • Central Screw Company • Continental Screw Company • The Eagle Lock Company • Elco Tool and Screw Corporation • Great Lakes Screw Corporation • The H. M. Harper Co. • The Lamson & Sessions Company • National Lock Company • The National Screw & Manufacturing Co. • Parker-Kalon Div. General American Transportation Corporation • Pheoll Manufacturing Co. • Rockford Screw Products Co. • Scovill Manufacturing Co. • Shakeproof Div. Illinois Tool Works • The Southington Hdwe. Mfg. Company Sterling Bolt Company • Universal Screw Company • Wales-Beech Corp.



Bicycle saddle by
H. & F. Mesinger Mfg. Co., Bethel, Conn.

Blackstone Automatic Washer made by
Blackstone Corp., Jamestown, N. Y.

"Nomar" anchor by
Whitman & Robinson,
Weedsport, N. Y.

Plastisols used in these products
were formulated by
Stanley Chemical Co., East Berlin, Conn.

Products on the *MOVE* - - with Plastisols

Here's an anchor that won't mar boat decks, because it's coated with soft, resilient plastisol . . .

A tough, weatherproof bicycle saddle with a red leather grain, rivet heads —even the stitching—all one piece, molded from plastisol . . .

And a washing machine collector tank coated and sealed on the inside —the work side—with durable plastisol.

Does some product of yours have to operate under conditions like these? Sea water, sun, scalding water, soap, corrosion, chemicals, abrasion, flexing . . . plastisols based on BAKELITE Brand Vinyl Dispersion Resins take them all in stride.

Easy-flowing plastisols are simple to work with, either for coating or molding. Use them for dip-coating, slush molding, injection molding. They form with little or no pressure, without harm to an assembly's delicate components. A short bake fuses them into a firm, resilient material. They have good electrical insulating properties. They can be given almost any color you wish. Their finishes can be glossy or soft.

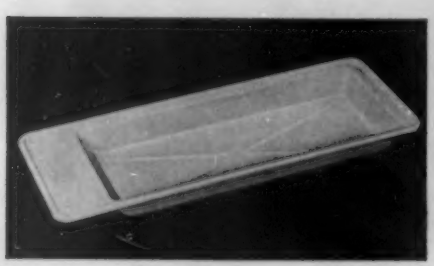
All these features result in a surprisingly low cost in terms of service and production advantages. For information and technical assistance in applying plastisols based on BAKELITE Vinyl Dispersion Resins, write Dept. HN-145.

BAKELITE
BRAND
Vinyl Dispersion Resins

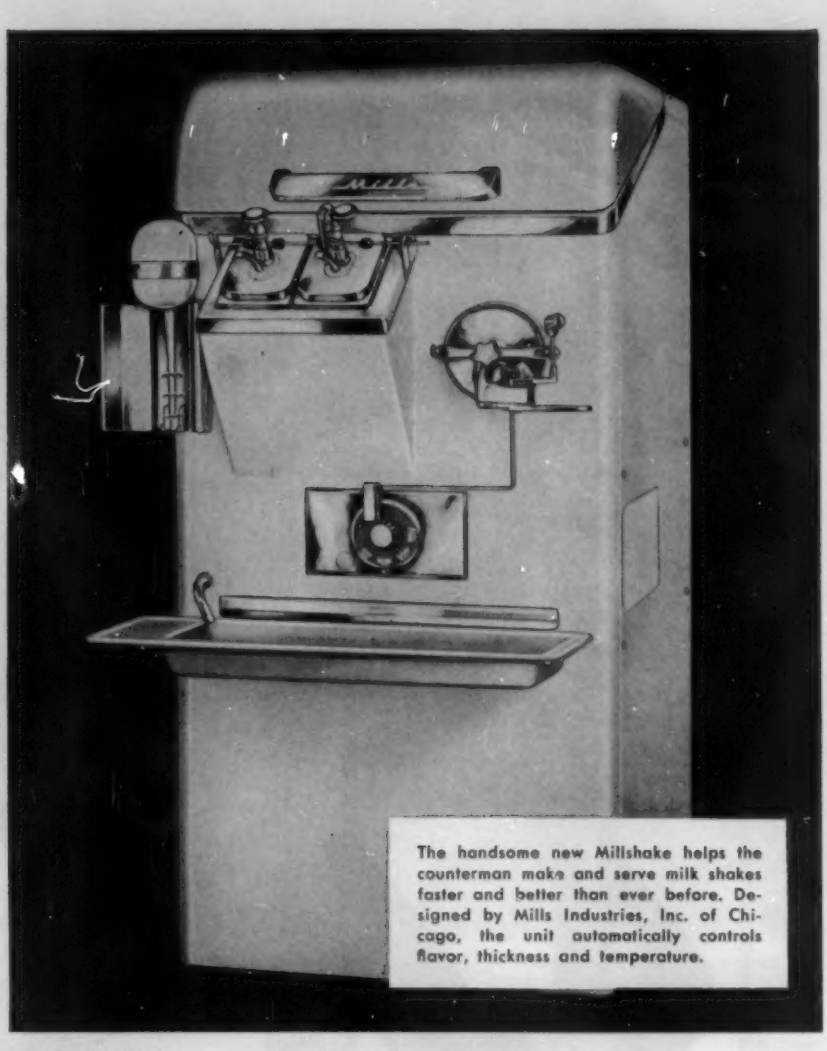
BAKELITE COMPANY, *A Division of Union Carbide and Carbon Corporation* UCC 30 East 42nd Street, New York 17, N. Y.

The term BAKELITE and the Trefoil Symbol are registered trade-marks of UCC

The top cover, formed of Campco by Arrem Plastics of Chicago, harmonizes with metal surface of the cabinet, yet it's so light even a child can lift it.



The drip tray is light blue Campco to provide a pleasing contrast with the white metal cabinet.



The handsome new Millshake helps the counterman make and serve milk shakes faster and better than ever before. Designed by Mills Industries, Inc. of Chicago, the unit automatically controls flavor, thickness and temperature.

How CAMPCO met 5 design requirements on the new Millshake

Several times a day, the drip tray of this new milk shake dispenser must be removed, cleaned and replaced quickly. The hinged top cover must also be cleaned ... but more important, it must provide an air-tight seal for the unit's refrigerated compartment.

That's why Mills Industries insisted that both parts have these five characteristics: (1) easy to clean, (2) easy to lift, yet (3) strong enough to take rough handling. What's more, (4) the cover – an inner and outer shell enclosing an insulation material – had to be easy and economical to manufacture to close tolerances ... and both parts (5) had to look clean and sanitary and harmonize with the gleaming metal surface of the cabinet itself.

Mills Industries found Campco S-300 rubber-styrene sheet ideal. It offers an easy-to-clean, porcelainlike finish in a wide range of colors ... excellent dimensional stability ... low moisture absorption ... and high impact strength. And this sheet can be formed quickly and economically to complex shapes ... on simple machines ... by practically any conventional forming technique.

Why not try Campco yourself? Ask one of our engineers for samples to try in your own plant. Or, if you prefer, write for literature first.

CAMPCO Division
Chicago Molded Products Corporation

2726 Normandy Avenue
Chicago 35, Illinois

Please send me your new folder on High Gloss CAMPCO GM plastic sheet.

Name_____

Company_____

Address_____

City_____ Zone_____ State_____

CAMPCO DIVISION OF
CHICAGO MOLDED PRODUCTS CORP.

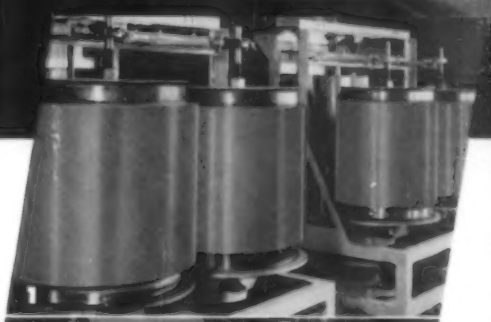
On the back of each color TV viewing screen are more than one million phosphor dots (19" screen) grouped in uniform patterns of red, green and blue. Electron beams registered with each dot are shot at these phosphors—the intensity determining the dominating color.
Directly behind the screen in each tube is a Cupro Nickel shadow mask containing more than 400,000 holes. Each hole is registered exactly with its group of phosphor dots on the screen and with the electron beam—the mask controls the register of color—keeps the image sharp —the color true.

Color TV came to ANACONDA

When the television industry needed a shadow mask to control electron beams in the color tube, Buckbee Mears Company, photoengravers of St. Paul, Minnesota, produced it. When they needed thin strip metal in which 2500 perfect holes per square inch could be etched, Anaconda produced it.

When color TV came to Anaconda, we developed a new alloy, 6% Cupro Nickel, with such uniform quality, structure and thickness (0.0075") that the microscopic holes could be etched without flaw. The new alloy also has the strength and malleability to take forming without distortion of the dot structure, and functions in a color tube without contaminating the vacuum.

Again, a copper alloy has solved a difficult problem. Perhaps yours can be made easier through Anaconda research and development. The American Brass Company, Waterbury 20, Connecticut. In Canada: Anaconda American Brass Limited, New Toronto, Ontario.


1

2

3

4

1 Rolls of the Cupro Nickel strip entering coating machine to be sensitized for photographic printing.

2 Camera printing dot pattern on the sensitized Cupro Nickel strip.

3 Printed Cupro Nickel strip at right entering etching machine where acid baths plus washing and rinsing operations produce finished mask.

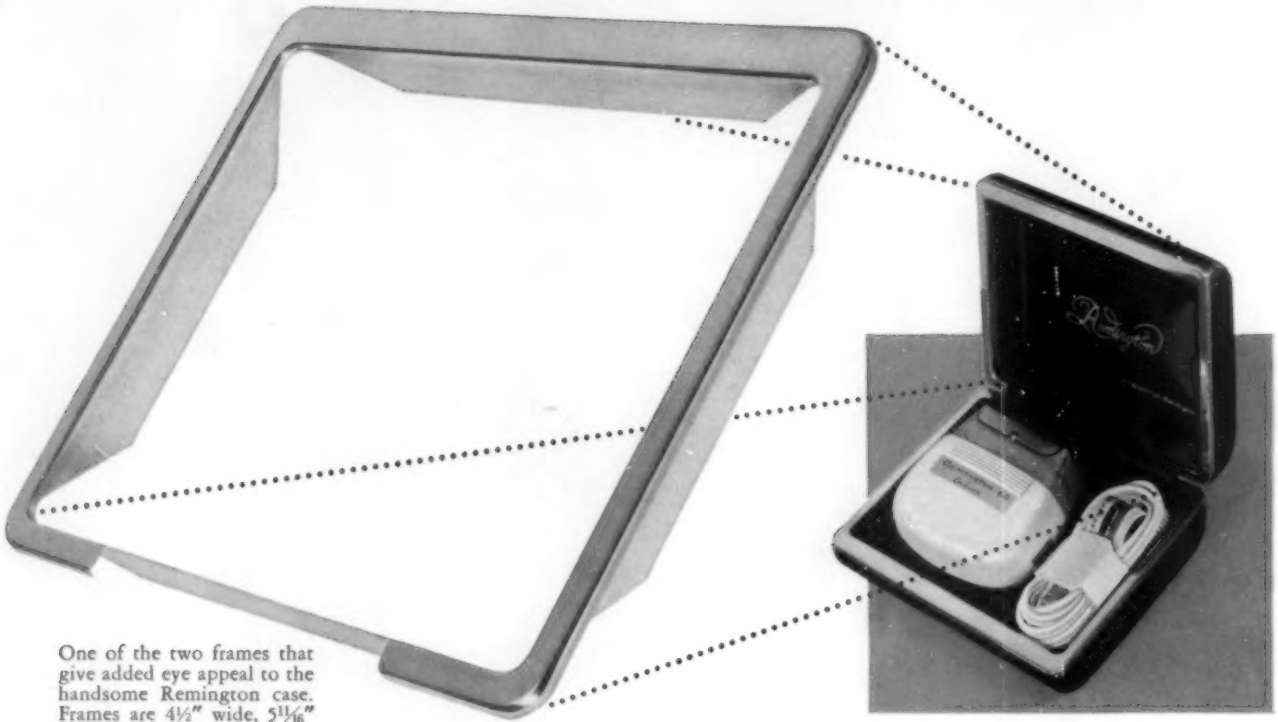
4 Each 19" shadow mask has more than 400,000 holes, size .010 ± .0005. Several areas of screen are inspected electronically to check hole size.

ANACONDA the name to remember in

COPPER • BRASS • BRONZE

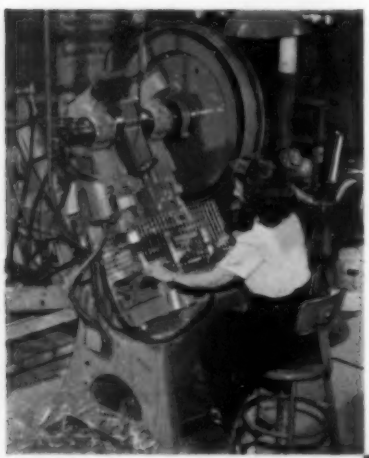
Rejects dropped from 11% to 1%

when Farrington switched to Formbrite for frames of Remington Shaver case



One of the two frames that give added eye appeal to the handsome Remington case. Frames are 4½″ wide, 5 1/16″ long and ½″ deep.

Formbrite* fine-grain drawing brass is harder, stronger, springier...often polishes in half the time



Press operator blanks frames for the Remington case out of 6″ x .0126″ Formbrite drawing brass strip.

Each day, thousands of these brass frames for the Remington-60 Deluxe Shaver case are made by Farrington Manufacturing Company of Boston. Using ordinary brass, rejects *after polishing* were running at the rate of 11%.

Then Farrington switched to Formbrite. Rejects dropped immediately to less than 1% . . . and with far less polishing Farrington now gets the best finish they've ever seen. And that's important because the Remington case helps sell the shaver.

You'll find Formbrite surprisingly ductile . . . it's readily stamped, formed, drawn and embossed. Yet with all its advantages, it costs no more than ordinary drawing brass. We'd like you to know this cost-saving metal better. May we send you descriptive literature (ask for booklet B-39)? A free sample to try in your own shop? Or have a representative call? Simply write to *The American Brass Company, General Offices, Waterbury 20, Conn.* In Canada: *Anaconda American Brass Ltd., New Toronto, Ontario.*

*Reg. U. S. Pat. Off

5577

Frames are set in fixture for finishing operation on this automatic, three-station polishing machine. Bright, lustrous finish is obtained in one pass through the machine.

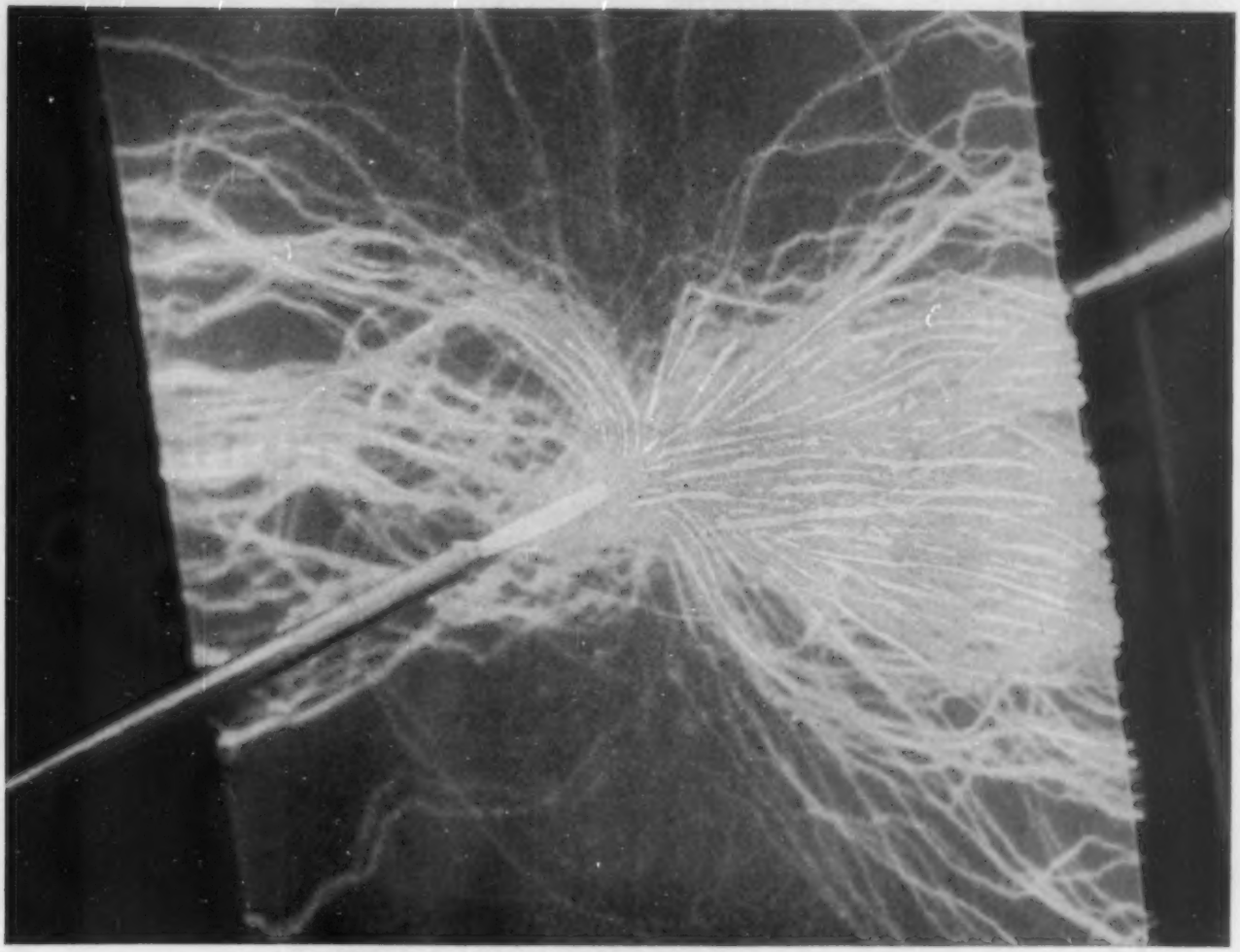
Formbrite

FINE-GRAIN DRAWING BRASS

AN ANACONDA® PRODUCT

made by The American Brass Company

ASTOUNDING... the insulating ability of this thin plastic film



CHALLENGING to industry... the combination of remarkable properties offered by Du Pont MYLAR*

The photograph above can mean something to you even if your product has nothing to do with electricity. A high-voltage blast passes around, rather than through, a thin sheet of new Du Pont "Mylar" polyester film. High dielectric strength —essential for any insulating purpose.

But that's just *one* of the many unusual properties offered by this new film.

"Mylar" is the strongest of all plastic films available. Important if you want to design miniaturized equipment, or need extra toughness and thinness for any purpose.

"Mylar" keeps its remarkable properties over a wide temperature range. Vital if your product operates under extremes of heat or cold.

"Mylar" resists the attack of many acids, bases, organic solvents. You can use it where many other materials would break down.

"Mylar" can be slit into yarn; metalized; it can be bonded to other substances to make vapor barriers, protective and decorative laminates. This opens a whole new range of applications.

DU PONT

MYLAR®

POLYESTER FILM

DU PONT

REG. U. S. PAT. OFF.

Better Things for Better Living ... *through Chemistry*

What about *your* product? It may pay you to find out about the amazing variety of products in which "Mylar" has already cut costs and increased efficiency. Send for your copy of a new fact-filled booklet and samples of this versatile new film. Mail the coupon below.

**"Mylar" is a registered Du Pont trade-mark for its brand of polyester film*

E. I. du Pont de Nemours & Co. (Inc.)
Film Department, Room 3P, Nemours Bldg.
Wilmington 98, Del.

Please send me sample and further information on "Mylar" polyester film.

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Firm_____

Street Address_____

City_____ State_____

Hinged Arm *prevents* Contact Troubles in MALLORY Rheostats

ONE OF THE IMPORTANT REASONS why Mallory Power Rheostats give superior performance is their unique hinged contact arm. Exclusive with Mallory, this construction assures correct pressure at all times, between the brush and the winding. You can lift the arm to clean or replace the brush . . . and the spring snaps back to exactly the right pressure. *The spring carries no current* . . . won't anneal and lose its tension during overloads.

Other notable design features are built into these rheostats. Ceramic insulation for current-carrying members is selected for high dimensional stability. Tough, impervious vitreous enamel protects the winding. Overall design assures good ventilation and cool operation at full ratings.

Precise linearity is obtained through Mallory-developed winding techniques. Special tapers can be produced with a *single* wire by means of Mallory variable pitch winding, which eliminates hot spots and points subject to breakage.

Standard Mallory rheostats cover the full range of most industrial applications . . . with ratings of 25, 50, 75, 100, 150, 225, 300 and 500 watts. In addition, we will be glad to engineer special single, dual or multiple units for your particular needs. Write to Mallory today for our Technical Bulletin describing all Mallory wire wound resistors and rheostats.

Parts distributors in all major cities stock Mallory standard components for your convenience.

Expect more . . . Get more from

Serving Industry with These Products:

Electromechanical—Resistors • Switches • Television Tuners • Vibrators
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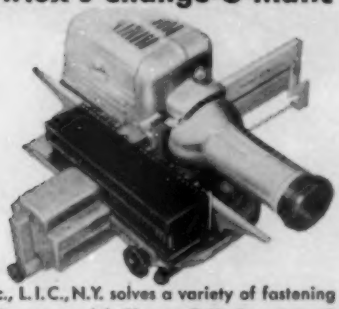
P. R. MALLORY & CO. Inc.
MALLORY
P. R. MALLORY & CO., Inc., INDIANAPOLIS 6, INDIANA

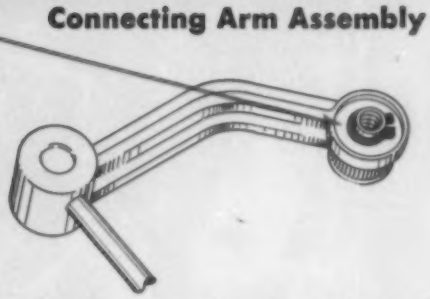
Waldes Truarc Rings Permit Better and More Economical Design—Fewer Parts, Faster Assembly, Minimal Rejects!

Viewlex's Change-O-Matic



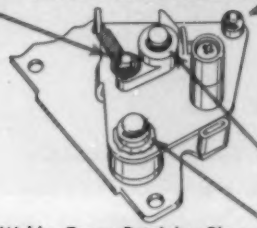
Viewlex, Inc., L. I. C., N.Y. solves a variety of fastening problems in their new model Change-O-Matic automatic slide changer. Assembly time is speeded, parts eliminated, rejects lowered, and compact, economical product design achieved.

Connecting Arm Assembly



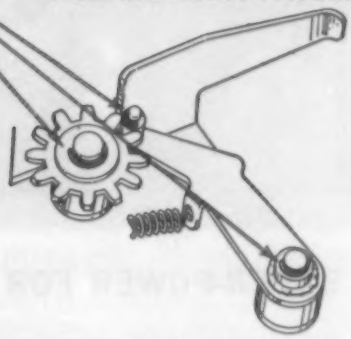
Use of one Waldes Truarc Ring (Series 5100) eliminates time-consuming riveting over the flange, retains and holds the connecting knob captive. A compact, neat design is made possible, rejects caused by poor riveting eliminated.

Actuating Plate and Pawl Assembly



Three types of Waldes Truarc Retaining Rings are used in this assembly. One circular self-locking ring (Series 5103) retains pawl return spring. One external E-ring (Series 5133) retains roller used to prevent gear motion during transport cycle. One crescent ring (Series 5103) retains pawl which indexes gear. Second crescent ring retains sub-assembly. Truarc Rings speed assembly, cut rejects, eliminate parts.

Dentent Lever Assembly



Truarc E-ring (Series 5133) eliminates use of tapped hole and shoulder screw, retains roller which prevents over-travel of gear. Assembly is rapid.

Whatever you make, there's a Waldes Truarc Retaining Ring designed to improve your product... to save you material, machining and labor costs. They're quick and easy to assemble and disassemble, and they do a better job of holding parts together. Truarc rings are precision engineered and precision made, quality controlled from raw material to finished ring.

36 functionally different types... as many as 97 different sizes within a type... 5 metal specifications and 14 different finishes. Truarc rings are available from 90 stocking points throughout the U. S. A. and Canada.

More than 30 engineering-minded factory representatives and 700 field men are available to you on call. Send us your blueprints today... let our Truarc engineers help you solve design, assembly and production problems... without obligation.

For precision internal grooving and undercutting...Waldes Truarc Grooving Tool!

Send for new catalog supplement

WALDES TRUARC® RETAINING RINGS

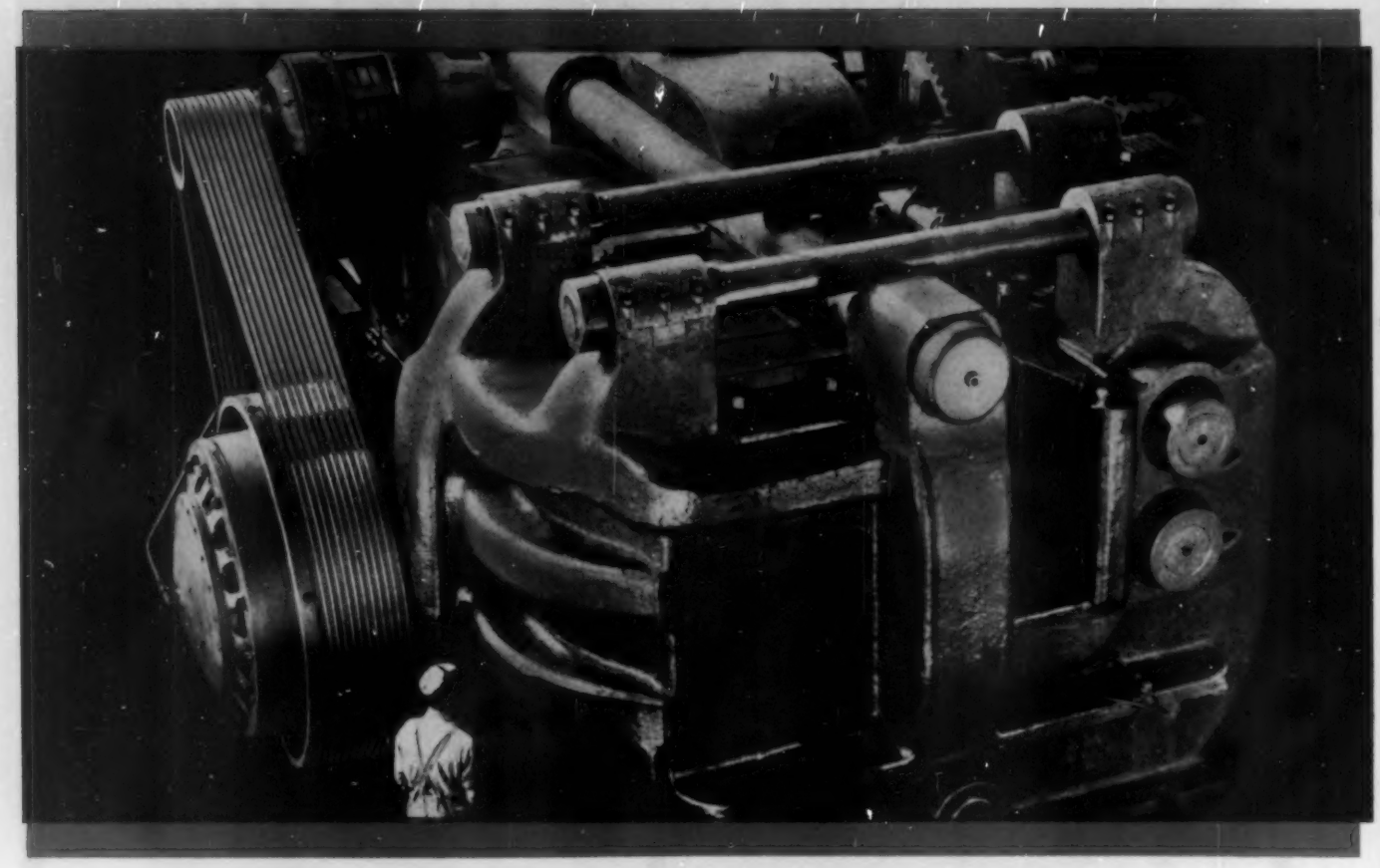
Waldes Kohinoor, Inc., 47-16 Austel Place, L. I. C. 1, N. Y.
Please send the new supplement No. 1 which brings Truarc Catalog RR 9-52 up to date.
(Please print)

*Name*_____
*Title*_____
*Company*_____
*Business Address*_____
*City*_____ *Zone*____ *State*_____

PN067

WALDES TRUARC Retaining Rings, Grooving Tools, Pliers, Applicators and Dispensers are protected by one or more of the following U. S. Patents: 2,382,948; 2,411,426; 2,411,761; 2,416,852; 2,420,921; 2,428,341; 2,439,785; 2,441,846; 2,455,165; 2,483,379; 2,483,380; 2,483,383; 2,487,802; 2,487,803; 2,491,306; 2,491,310; 2,509,081; 2,544,631; 2,546,616; 2,547,263; 2,558,704; 2,574,034; 2,577,319; 2,595,787, and other U. S. Patents pending. Equal patent protection established in foreign countries.

CALL ON R/M ENGINEERING SERVICE



SUPER-POWER FOR HEAVY DUTY V-BELT DRIVES

New stretchless, super-strength synthetic cords in R/M Super-Power V-Belts provide up to 40% more power than regular V-belts on heavy duty drives requiring extra horsepower. This means you can increase the horsepower capacity of a drive as much as 40% *without* changing the drive design . . . or save space in new drives by using narrower sheaves and fewer belts to meet required horsepower specifications. R/M Super-Power V-Belts have exceptional elastic resistance to shock loads, virtually eliminate belt matching problems. With straight sidewalls, these belts assure better tensioning and grip, less slip and longer belt life on the most rugged drives.

Precision balancing of all component parts during manufacture provides the smoothest running, most durable V-Belt for heavy duty service. R/M's all-synthetic rubber construction further makes R/M Super-Power V-Belts oil-proof, non-spark and heat resistant. Write for Bulletin 6628.

You'll find the same advanced engineering in Condor V-Belts for general drive applications, as well as in R/M rubber hose, conveyor belt, flat transmission belting and molded or extruded rubber parts. Let R/M specialists work with you on your next new design . . . or to improve present equipment performance.

For booklet shown, or other data, write, phone or wire:

MANHATTAN RUBBER DIVISION
Raybestos-Manhattan, Inc.
Passaic, N.J.
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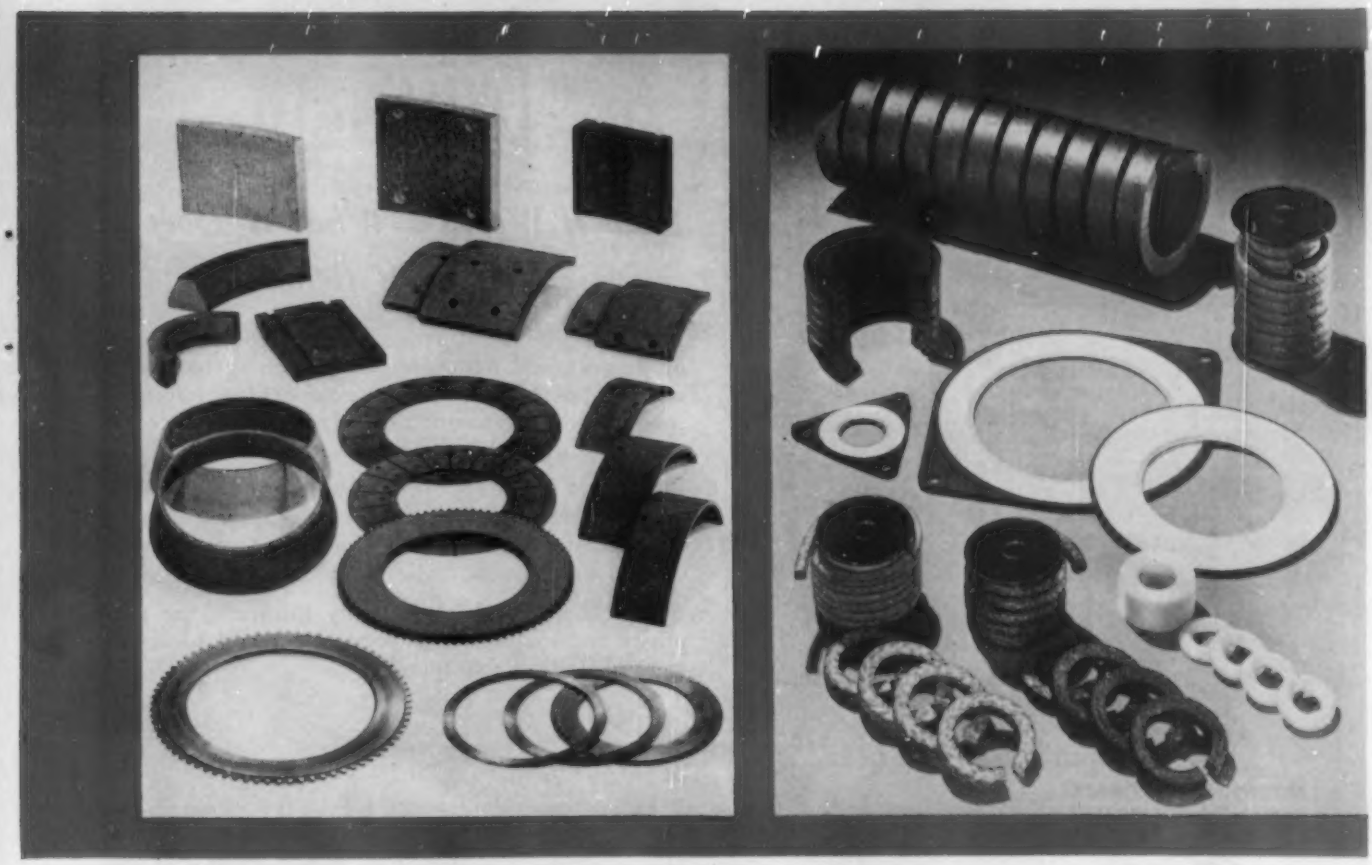
FOR HELP IN SOLVING YOUR PROBLEMS



FRICTION MATERIALS

Unlike other manufacturers, R/M works with *all* kinds of friction materials, from asbestos to sintered metals. This means that when you consult an R/M engineer you can be sure of completely unbiased advice on which materials are best for your application.

Raybestos-Manhattan has been the world's largest maker of friction materials for over 50 years. Whatever your brake or clutch requirements, count on R/M experience, and R/M manufacturing and testing facilities, for a friction material exactly suited to your needs.

Write for your copy of R/M Bulletin No. 500. It's loaded with practical design and engineering data on all R/M friction materials.

EQUIPMENT SALES DIVISION
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Chicago 31, Ill.
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PACKINGS, GASKETS ASBESTOS TEXTILES and "TEFLON"* PRODUCTS

If you have a packing problem, don't hesitate to call on R/M's specialized packing engineering service. R/M has the right type of engineered packing or gasket sheet, no matter what you are sealing: air, gas, water, steam, oil, solvents, foods or hydraulic fluids. Consult R/M also if your requirements call for asbestos textiles or "TEFLON" products. Take full advantage of R/M's many years of experience in all of these fields. Write for booklet on packings, gaskets and "TEFLON" products.

**Du Pont's trade-mark for its tetrafluoroethylene resin*

For booklet shown, or other data, write, phone or wire:

PACKING DIVISION OR ASBESTOS TEXTILE DIVISION
Raybestos-Manhattan, Inc.
Manheim, Pa.
Manheim 5-2211

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Conveyor Belts

Rubber Lined and Covered Equipment

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Asbestos Textiles

Teflon Tape, Packings, Sheets, Rods, Tubes

Engineered Molded Rubber and Plastics

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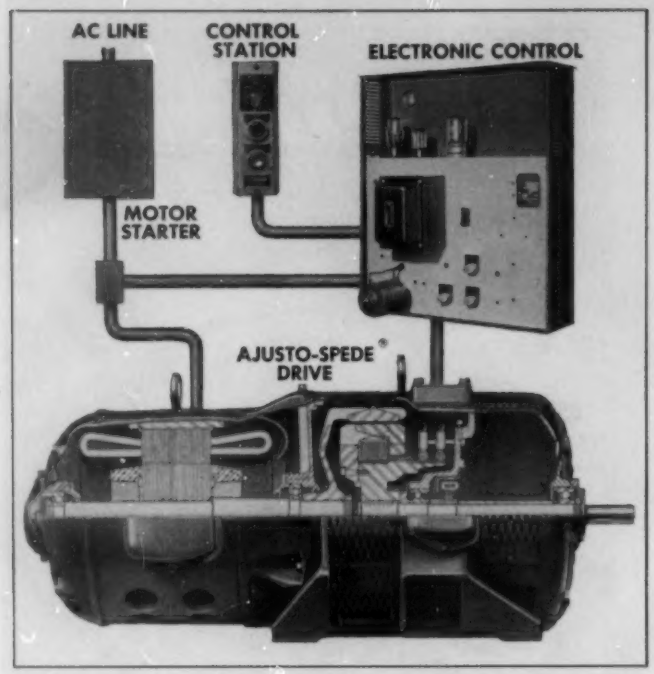
SPEED CONTROL BY



DYNAMATIC®

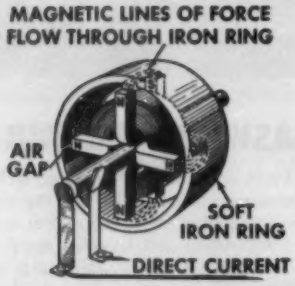
How it Works — What it Does — Why it's Better

Increased production, reduced costs, improved quality of product, and more complex processing techniques demand an ever increasing use of stepless adjustable speed drives. Dynamatic eddy-current equipment in one form or another attains these objectives.

Dynamatic Ajusto-Spede® Drives, Air and Liquid Cooled Couplings, Air and Liquid Cooled Brakes, Absorption, Motoring, and Universal Dynamometers operate on the same basic electro-magnetic principle.

A typical installation pictorially illustrates the simplicity and minimum components required to obtain controlled adjustable speed.

Basic Principles of Operation



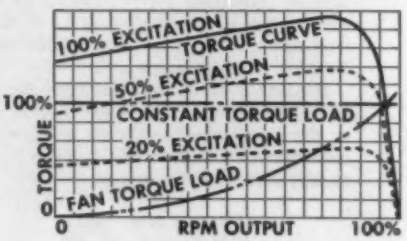
The transmitting of torque by Dynamatic eddy-current devices is based upon a simple magnetic principle easily demonstrated by the physics experiment, using a horseshoe magnet, iron filings, and a piece of cardboard. If several unmagnetized soft iron bars in the shape of a U, illustrated in the above drawing, are inserted in an insulated coil of wire, the bars will become magnets when direct current flows through the coil. Strength of the magnetic field is determined by the current flowing and the number of turns in the coil. By adding a solid ring of soft iron, encircling the poles of the electromagnets, the magnetic lines of force will flow through the ring. The basic construction of all Dynamatic eddy-current rotating equipment is then simulated.

The illustration shows magnetic lines of force with no relative rotation between the ring and magnets. When the field assembly (magnets and coil) is rotated mechanically, the iron ring separated from it by a nominal air gap remains stationary until current is applied to the coil. With the coil energized, mechanical rotation of the magnets produces movement of magnetic flux in the ring, creating eddy-currents in the ring. These induced currents develop a second magnetic field. Its strength is determined by the strength of the primary field and the relative speed difference (slip) between the two members. In the eddy-current coupling, attraction of these two fields cause the ring to follow the field magnets in rotation. When the coil current is varied, the eddy-currents will be proportionately affected, and torque produced at the output shaft will be similarly changed.

A typical eddy-current coupling torque curve with rated excitation and additional curves with reduced excitation is shown. In the same figure, a constant torque and fan torque load curve is plotted. Excess torque, which is a measure of accelerating capacity, is indicated. The Dynamatic coupling transmits this torque from a driving member, that may be either the drum ring or field magnets, to a driven member without mechanical contact.

Because of the extremely small excitation requirements, Dynamatic units lend themselves readily to electronic or magnetic amplifier control.

By taking advantage of the very high amplification factor of these controls, the largest couplings can be easily and conveniently controlled with a small adjusting potentiometer. The voltage output of a permanent magnet alternator mounted on the coupling output shaft varies directly with the shaft speed. This variable voltage signal modulates the control, automatically maintaining the selected speed of the coupling output shaft, within close limits, over a wide speed range.



Other features are easily incorporated—constant tension, controlled acceleration, threading, jogging or inching, torque limit, speed matching, and many others.

The relative simplicity, smoothness of operation, accuracy, ease of control and low maintenance of Dynamatic eddy-current equipment are factors meriting serious consideration of this type of equipment on almost all adjustable speed applications.

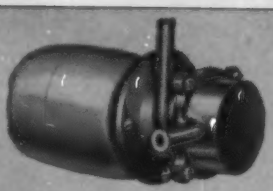
A free copy of the Dynamatic General Bulletin describing eddy-current equipment in more detail is available. Write for your copy.

EATON

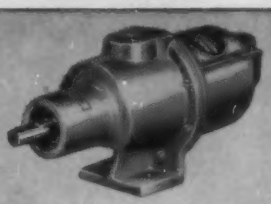
DYNAMATIC®

DIVISION • EATON MANUFACTURING COMPANY

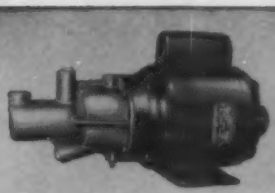
3300 FOURTEENTH AVENUE • KENOSHA, WISCONSIN



Moyno designed for pumping ethylene glycol, condensate from automatic driers, hot and cold water in dishwashers.

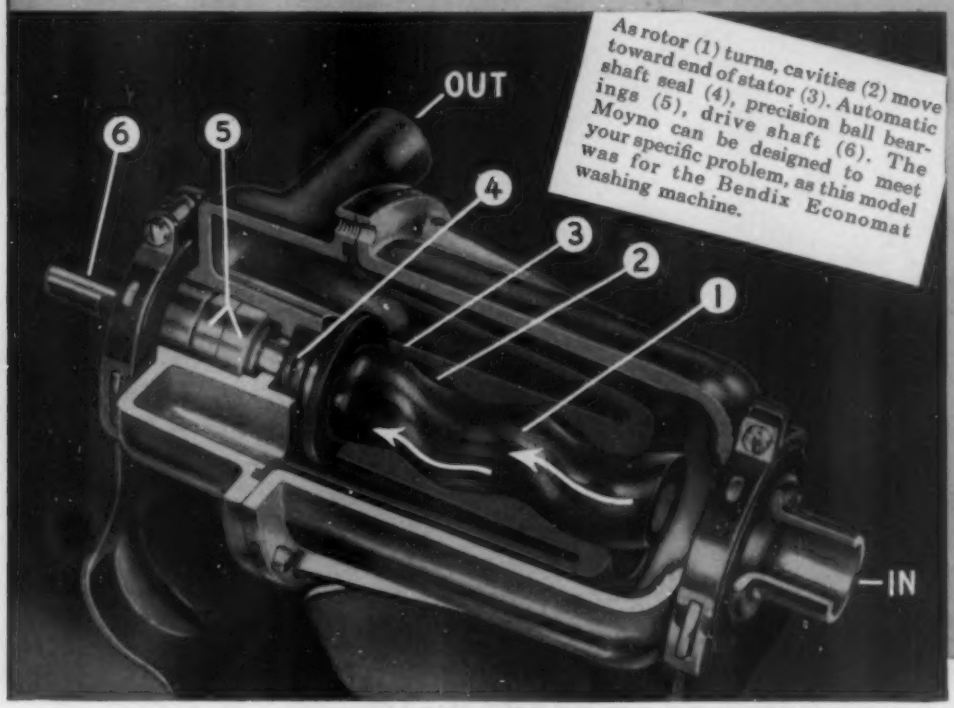


General purpose Moyno for pumping oils, water, alcohols and caustics.



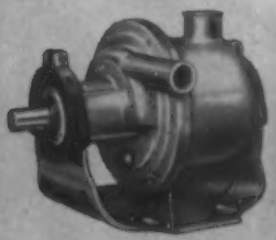
Bronze and stainless steel Moyno as used in a drink dispenser. Pumps water at more than 100 p.s.i.g.

Here's a compact version of a low head, small displacement Moyno for accurate pumping of small amounts.



As rotor (1) turns, cavities (2) move toward end of stator (3). Automatic shaft seal (4), precision ball bearings (5), drive shaft (6). The Moyno can be designed to meet your specific problem, as this model was for the Bendix Economat washing machine.

Versions of this compact Moyno are applicable as coolant pumps, shallow well pumps and booster pumps.



Economical Moyno for the appliance field, designed for use under flooded head.

BEFORE YOU "FREEZE" YOUR PRODUCT DESIGNS...

Read these FACTS about MOYNO® PUMPS!

One of these characteristics may improve YOUR product!

Versatile—Pumps liquids, pastes, abrasive-laden slurries. Adaptable to heavy industrial machinery or small drink dispensers, oil burners, dishwashers, sprayers, coolant pumps, etc.

Positive Displacement—Moynos are available to pull up to 29″ of vacuum while discharging under pressure. Big Moynos can deliver up to 250 gpm. Pressures to 600 psi obtainable. Provide controllable, non-pulsating flow for metering purposes, in either direction!

Gentle—No churning, foaming; won't break up semi-solids. One Moyno is pumping potato salad!

Trouble-Free—Self-priming; won't cavitate or vapor-lock. Just one moving part—no valves to stick, no pistons to gum up. Low starting and running torque.

What you see here are seven variations of a *completely different concept of pump design* . . . the R&M "Moyno" Pump. It operates on a unique progressing-cavity principle, as shown by the large cutaway.

But even more important than how it works is how it *performs*. A good example is the Bendix Economat Washer, on which Moyno Pumps last *seven and a half times longer* than any pump tried before! On other types of applications—pumping everything from water, air, and abrasive-laden liquids to heavy, non-pourable pastes—users find that the simple Moyno Pump design saves maintenance dollars!

If you use pumps—and particularly if your pumping application is a little different—*there's a strong possibility that the Moyno can add new features to your product.*

New Bulletin No. 50-PD has more facts

Contains performance curves and details on pumping characteristics. Write for your free copy. If you can describe your application, we will be able to reply in even more detail.

ROBBINS & MYERS, INC.

SPRINGFIELD 99, OHIO • BRANTFORD, ONTARIO

R&M®

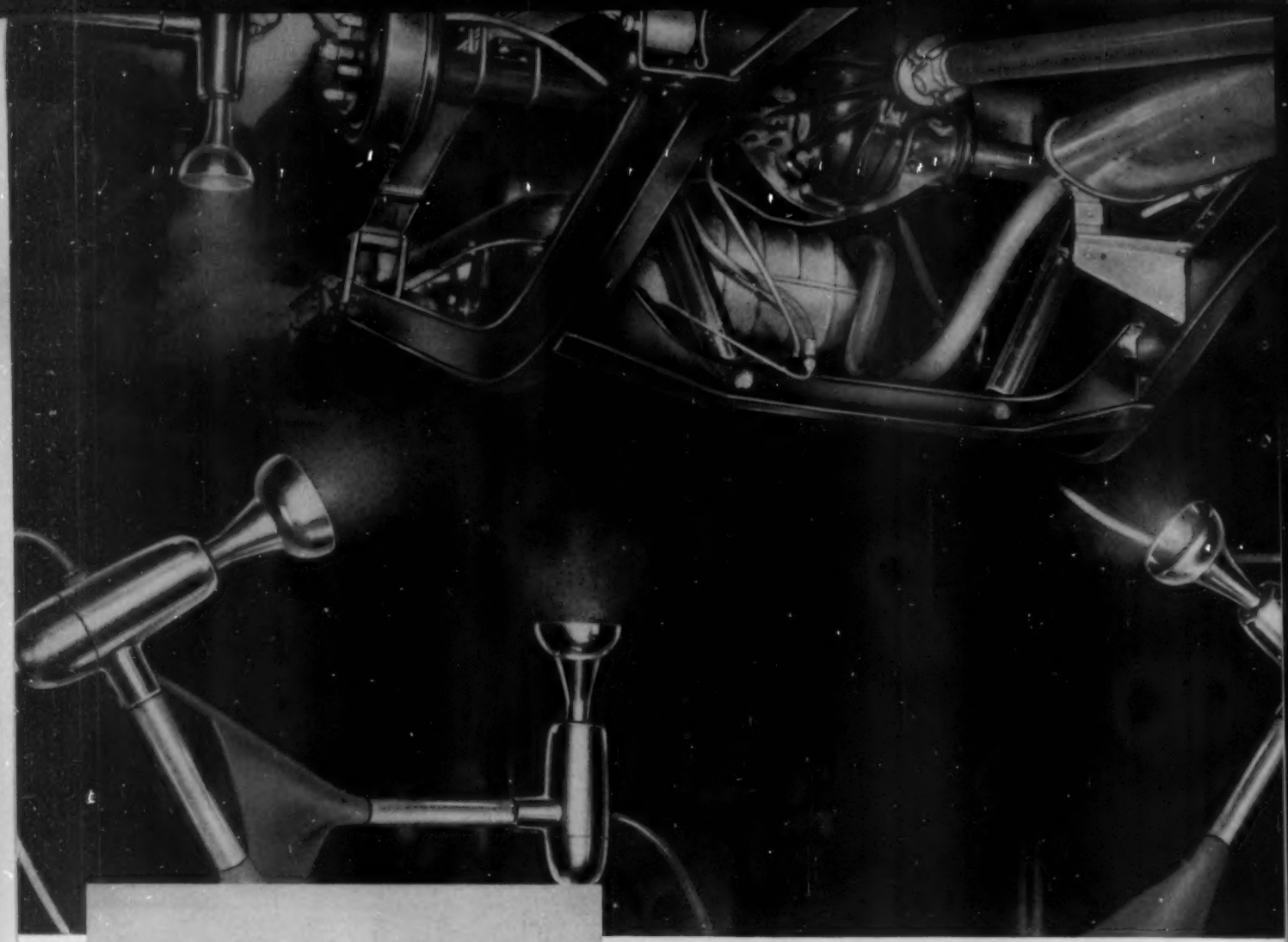
Fractional & Integral h.p. Motors & Generators

Electric Fans

Electric & Hand Hoists & Cranes

Moyno Pumps

Propellair Industrial Ventilating Equipment



R&M MOTOR PARTS AT WORK

A prominent passenger car manufacturer gets eleven times more chassis per gallon—reducing paint and production costs substantially—with the efficient, high-quality electrostatic paint spray process of the Ransburg Electro-Coating Corp., Indianapolis, Ind. Robbins & Myers polyphase motor parts are utilized to atomize the paint spray in an electrostatic field. The spray is attracted to the products, which are grounded through the hanger, producing a high degree of uniformity of finish.

◀ Rugged rotor and stator for a polyphase portable tool. The rotor consists of squirrel cage, embedded in laminated core with bars and end rings of copper, brazed or welded together. The stator has a high-grade silicon steel core with top-quality rag paper used to insulate the coil from the core. The finished winding is taped and thoroughly impregnated with high-grade synthetic resin base varnish to assure trouble-free operation with minimum danger of short circuits and grounds.

ROBBINS & MYERS, INC.

MOTOR DIVISION: SPRINGFIELD 99, OHIO • BRANTFORD, ONTARIO

Fractional & Integral h.p. Motors & Generators

Household Fans

Electric & Hand Hoists & Cranes

Moyno Pumps

Propellair Industrial Ventilating Equipment

R & M SPECIALISTS INTEGRATE MOTOR AND MACHINE DESIGNS... TO ASSURE HIGHEST PERFORMANCE

Many factors must be considered in designing a new motor-operated product that will perform its intended functions accurately, economically, and with a low maintenance and failure rate. Much depends on the proper correlation and integration of motor and machine designs. A special knowledge of motor application can be valuable to you. Robbins & Myers motor design specialists can help you solve these problems, to whatever extent you desire.

The exact motor for your machine is worked out quickly and accurately, with systematic methods of designing motors. This might include, for example, the use of R & M's unique "Electrical Slide Rule." Electrical equivalents can be set up on the slide rule to simulate the conditions under which the motor must operate in your product. By this method we are able to investigate hundreds of different design possibilities, assuring the best motor for the job.

In some cases the answers point to a standard motor. And here, R & M offers a wide variety of types and sizes of complete motors or matched motor parts.

In other cases special motors are indicated. R & M is equipped to do a fast, thorough, economical job of custom-designing a motor that's exactly right for your product.

Don't settle for an "off-the-shelf" compromise. Standard or custom-designed, R & M will get you the right answer quickly —with no obligation!

R & M MOTORS AND MOTOR PARTS POWER MANY TYPES OF EQUIPMENT, SUCH AS . . .

Portable Saws	Routers	Nut Setters	Hedge Trimmers
Drills	Screw Drivers	Hammers	Lawn Mowers
Nibblers	Pumps	Polishers	Oil Burners
Lock Mortisers	Compressors	Planers	Surgical Instruments
Valve Grinders	Hones	Portable Grinders	Grease Guns
Vacuum Cleaners	Business Machines	Sirens	Vibrators
Fans	Cast Cutters	Advertising Devices	Die Sinkers
Sanders	Food Mixers	Ventilating Equipment	Waxers

R&M MAKES BOTH!
Fractional-horsepower motors and parts . . . from 1/200 h.p.

If it's an R&M, it's the Right Motor!

Integral-horsepower motors; famous R&M "All-Weather"* with sealed bearings. Up to 200 h.p.

*"*All-Weather*" *is an R & M trademark*

This coupon will bring you prompt information. PD

Robbins & Myers, Inc., Motor Division, Springfield 99, Ohio

Please send me, without obligation, information on:

- ☐ Motor Parts for Portable Tools
- ☐ Universal Motors
- ☐ Capacitor Motors
- ☐ R & M "All-Weather" Motors —up to 200 h.p.
- ☐ Please have a Motor Specialist call

Product we manufacture: _____

Name _____

Title _____

Company _____

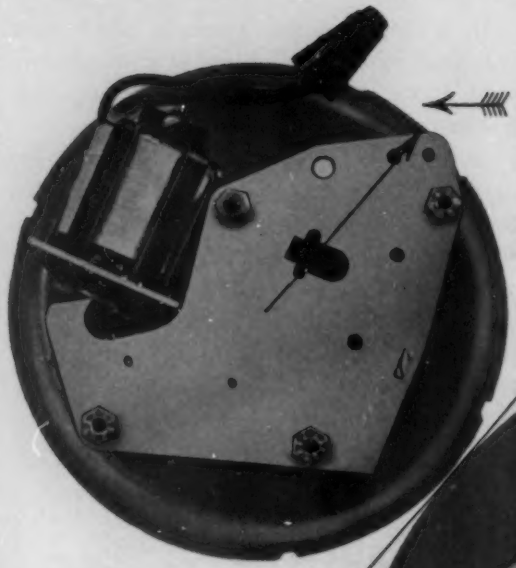
Street _____

City & State _____

Gilbert's revolutionary new electric clock motor is the

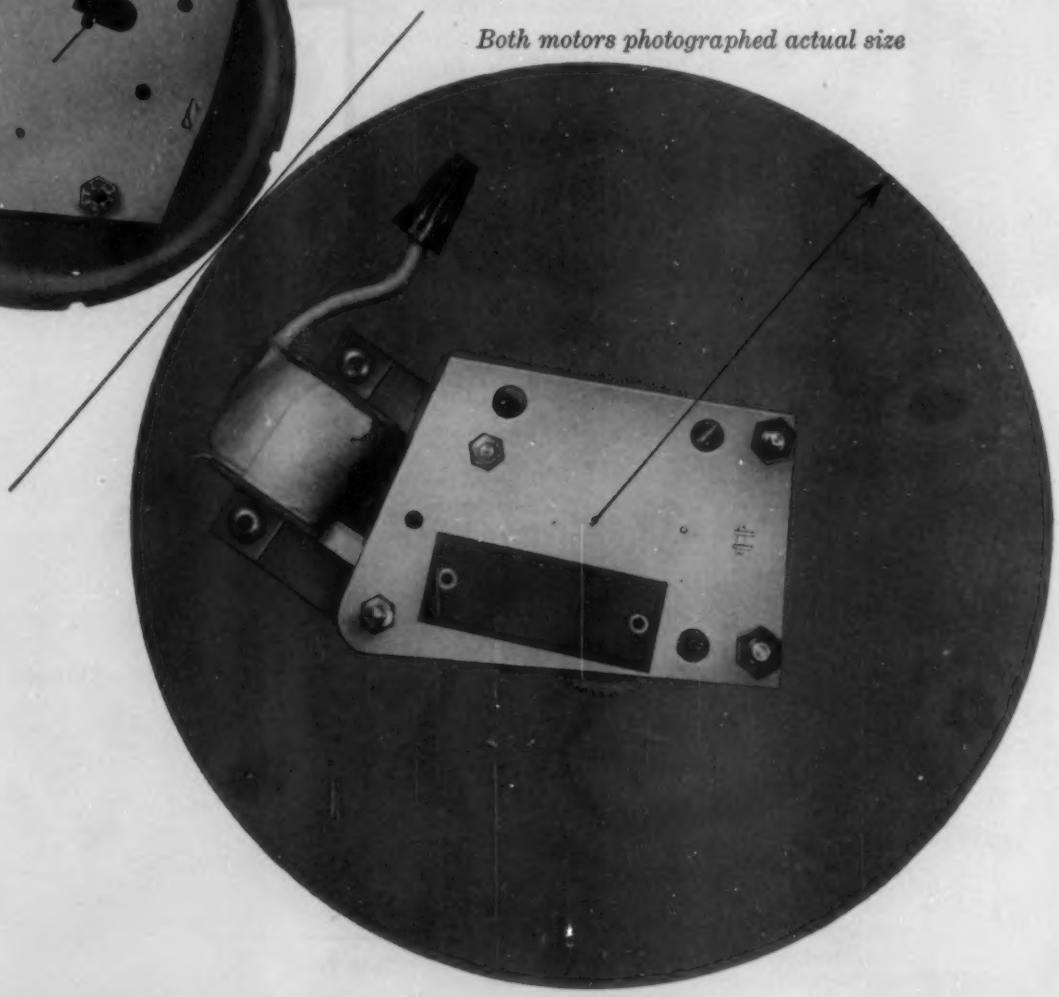
LOWER-PRICED...SMALLER-SIZED...SELF-STARTING FIT-UP...F-19

Here's one of the greatest engineering achievements in electric clock history—an improvement that can help *you* create *faster* selling models...earn *larger* profits. The F-19 unit's patented direction control reduces size ...cuts your production cost...and permits clock designs never before possible. Write, wire or phone for full details and low prices *today*, and see why this new Gilbert F-19 unit can be a real profit maker for you.



COMPARE THE COMPACT GILBERT F-19 pictured on the left with the bulkier, space-wasting old fashioned unit shown to the right. Reduction of space requirements for old-style FIT-UP's now permits clock designs *previously impossible.*

Both motors photographed actual size

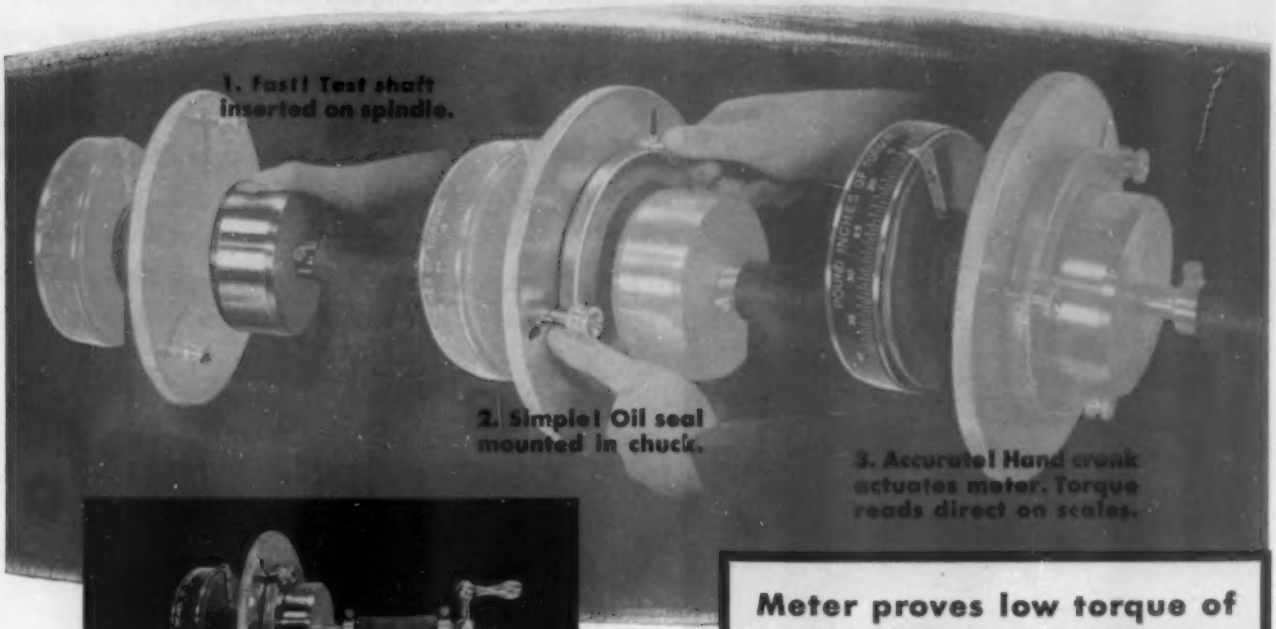


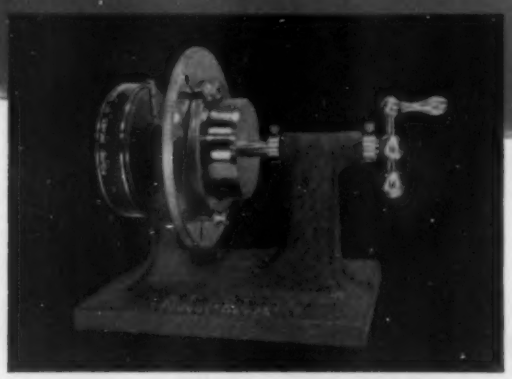
Clock makers to the nation since 1807

WILLIAM L. GILBERT CLOCK CORPORATION, WINSTED, CONNECTICUT

Now! MEASURE OIL SEAL TORQUE

quickly, accurately, by hand!


1. Fast! Test shaft inserted on spindle.
2. Simple! Oil seal mounted in chuck.
3. Accurate! Hand crank actuates meter. Torque reads direct on scales.



New NMB Portable Torque Meter

For years, industry has needed a fast, accurate means of measuring oil seal torque for standards determination or during quality control and parts inspection.

The new NMB Portable Torque Meter offers laboratory accuracy for such measurements, yet is rugged, fool-proof, and easily used by production line or receiving department personnel. A minimum of operator training is required; readings are instantaneous and direct.

Two models are offered. Model 615 reads torque to 15 lb. in. on seals from ¾" to 6" diameter; Model 845 reads torque to 60 lb. in. on seals from 2¾" to 8" diameter. Both have a simple, self-centering chuck which accurately positions the seal, and employ standard tapered shafts (special to order). The meters are lightweight (about 27 lbs.) and quality built for years of dependable service. A carrying case is available.

Meter proves low torque of NATIONAL OIL SEALS

National Torque Meters give quick, convincing proof that National Oil Seals have lowest torque.

National Micro-Torc Leather Oil Seals have appreciably less torque than conventional leather seals. National Syntech® synthetic rubber seals also test materially less torque than ordinary synthetics.

Micro-Torc seals achieve their remarkably low torque from a high lubricity coating applied to the surface of the sealing member. (Inside of sealing member retains natural porosity and stores oil for semi-starved operation.)

Syntech Oil Seals have the famous National "minimum-contact" sealing lip which, combined with precision tensioning, insures the lowest torque consistent with effective sealing.

NATIONAL MOTOR BEARING CO., INC.

General Offices: Redwood City, California
Plants: Redwood City, Calif., Downey (Los Angeles County), Calif., Van Wert, Ohio

NATIONAL
OIL & GREASE SEALS
O-RINGS SHIMS
®

Call in a National Field Engineer

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DALLAS, TEXAS . . . *30½ Highland Park Village, JUstin 8-8453*
DETROIT, MICH. . . . . *726 Lothrop Avenue, TRinity 1-6363*
DOWNEY (Los Angeles Co.), CALIF. . *11634 Patten Rd., TOpas 2-8166*
INDIANAPOLIS, INDIANA . *2802 North Delaware St., WAlnut 3-1535*
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"This certainly gives you a healthy respect for the orders design consultants can give us."

Consistent sales and advertising contacts with consulting design engineers can pay big dividends in the Original Equipment Market. Every consulting engineer sold on your products can do much to bring you volume orders from an impressive list of his client companies . . . and these companies often are among the biggest buyers of parts, materials, components, and finishes.

The "multiple-reaction" buying influence of consulting design engineers is clearly documented in a new *Product Engineering* market study.* It pinpoints a very important sales job for your advertising to the Original Equipment Market, and one that *Product Engineering* is eminently able to handle for you:

Among this magazine's 29,000 paid subscribers are 2,492 consulting design engineers, who serve a list of important client companies pages long. Sell them on your products, and you've taken a major step toward more business in the ever-growing O.E.M.

**Ask your advertising agency to get a copy of "New Facts About the Buying Power of Consulting Engineers" for you, or write directly to us in New York.*

And remember, please, that the power and influence of *Product Engineering* among consulting design engineers is only *one* element in this magazine's unmatched coverage and penetration of the O.E.M.'s buying influences. An important one, yes, but just a small part of the story behind *Product Engineering's* unquestioned acceptance as the major advertising medium in this $30-billion market. The more you study the facts, the more reasons you'll find for putting a hard-hitting, consistent advertising program in *Product Engineering*. Strong advertising to this market, *right now*, will pay you big dividends this year, and for many years to come. Ask your advertising agency to give you all the facts.

"Yes, it does . . . and another big reason for advertising in *Product Engineering*."

NEW FACTS
about the buying power
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CONSULTING ENGINEERS
a study of the "multiple-reaction" buying influence exerted by the men all industry consults for new ideas in product design
Product Engineering
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THE MEN
WHO DESIGN
AMERICA'S
NEW PRODUCTS
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The McGraw-Hill Magazine of Design Engineering
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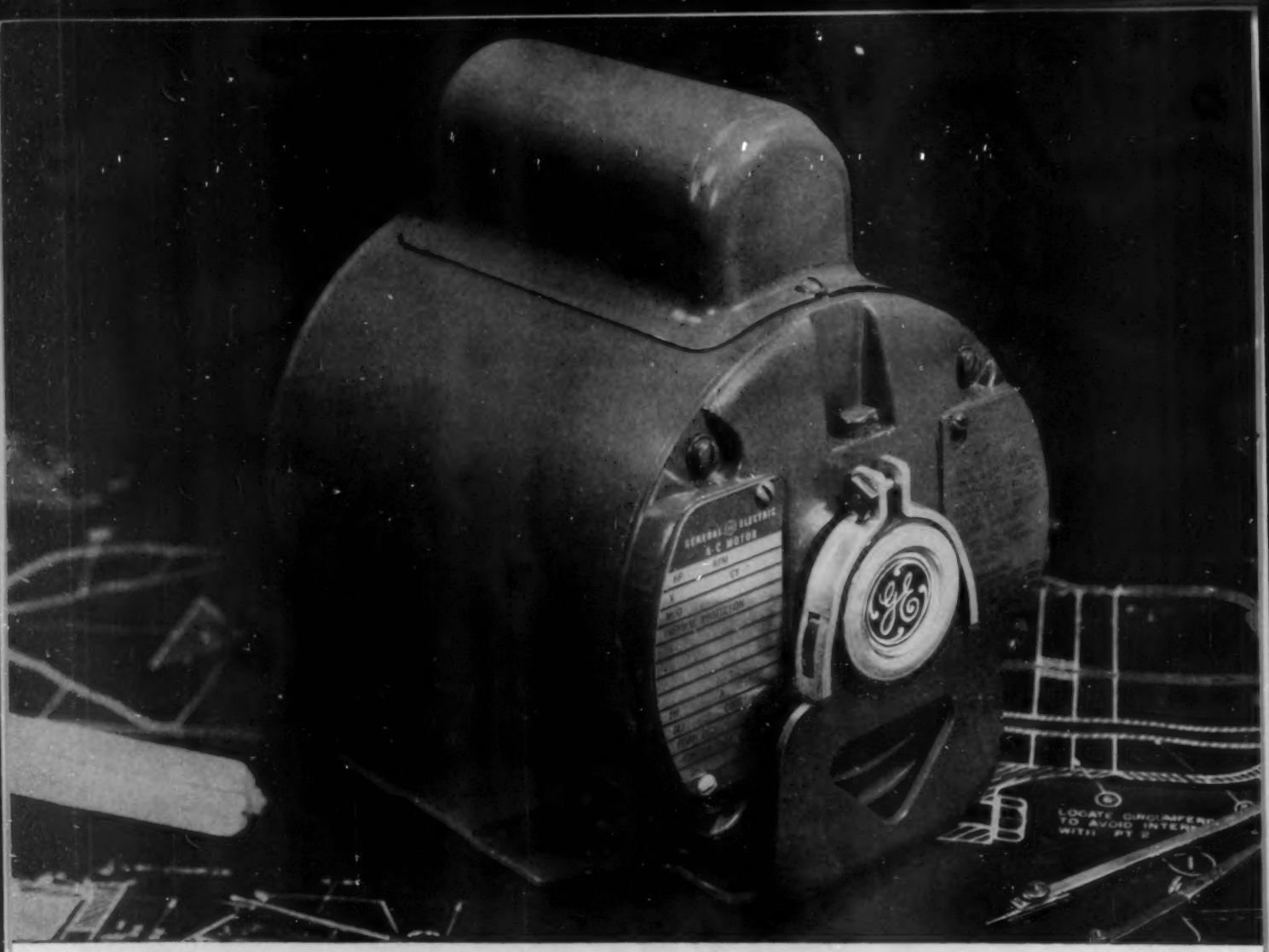
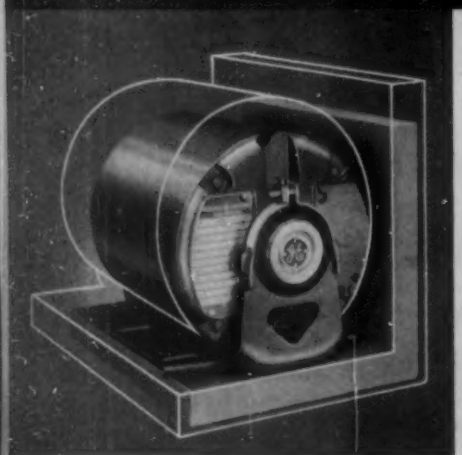


Get proved performance, big savings

SAVE ALL 3 WAYS WITH SMALLER, LIGHTER G-E MOTORS

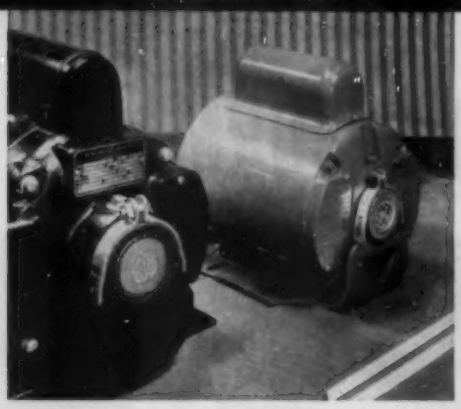


ON MATERIAL—You can design smaller, lighter motor mountings and housings—improve products at same time.

ON ASSEMBLY—Your assembly personnel will produce more efficiently with less fatigue when installing easy-to-handle G-E motors.

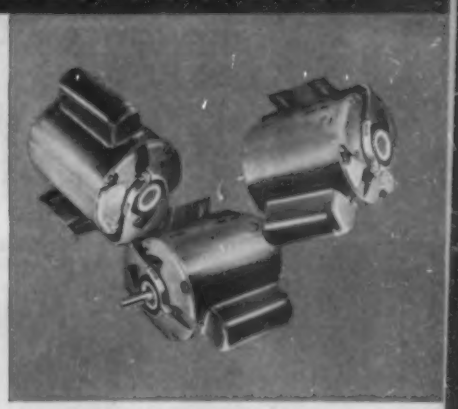
ON TRANSPORTATION—Save up to $1 per unit, depending on size and nature of product and distance shipped.

ONLY G.E. OFFERS ALL THESE SUPERIOR FEATURES

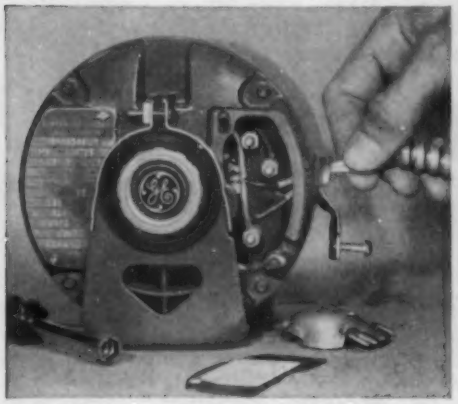


SMALLER, LIGHTER DESIGN—as much as 40% smaller and 50% lighter—saves for you on every step from design to shipping.

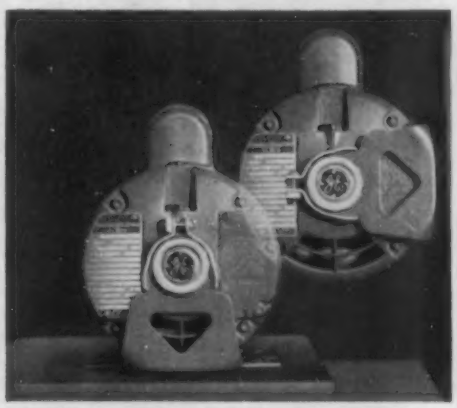
MYLAR* INSULATION (right) has over 35 times the moisture resistance and 8 times the dielectric strength of paper insulation (left).



ALL-ANGLE OPERATION—in any position lubrication is sure and protective; no need for costly specials.



EASY CONNECTION—terminals are close to cover plate; speed-nut welded inside shell permits fast connection from outside.



MOUNTING VERSATILITY—with resilient *or solid* cradle bases, you can rotate *any* motor, or easily remove cradle, to meet design needs.

DOUBLE LUBRICATION LIFE—50% more oil, and efficient oil retention system cut maintenance.

NOW with these advanced G-E motors

3 million in use demonstrate benefits on wide variety of products

Three years ago, General Electric pioneered the smaller, lighter fractional-hp motor. More than 3 million of these advanced G-E motors are now providing outstanding performance on the products of thousands of manufacturers. These manufacturers have realized tremendous savings on material, shipping, and assembly costs.

Today, with these savings encouraging complete conversion to smaller, lighter designs, only the advanced G-E motor provides you all of the superior features listed above. And General Electric offers you high-volume delivery *now* of smaller, lighter fhp motors for every application.

APPLICATION AID—from engineers who have helped thousands of manufacturers improve products with smaller, lighter G-E motors—is available to you. Contact your local G-E Apparatus Sales Office. For more information on advanced G-E fhp motors, write Sect. 702-21, General Electric Co., Schenectady 5, N. Y.

*DuPont trade-mark.

Progress Is Our Most Important Product

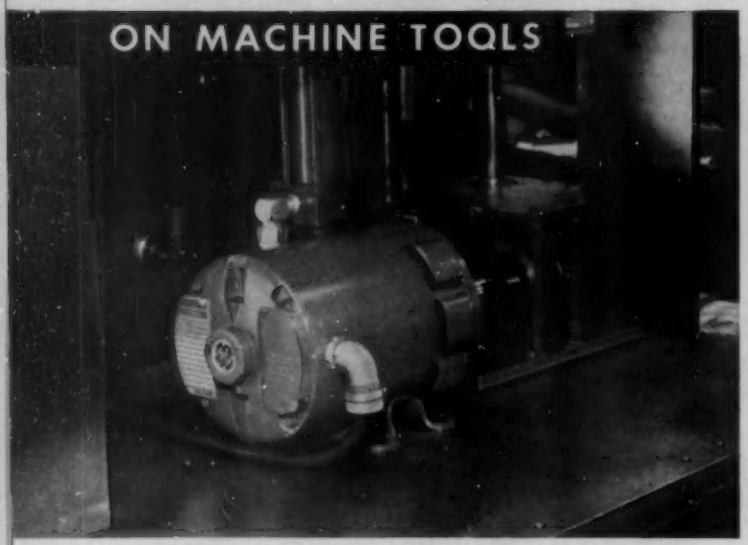
GENERAL ELECTRIC

ON NEXT PAGE
4 examples of
G-E motor benefits
in action

How advanced G-E fhp motors help

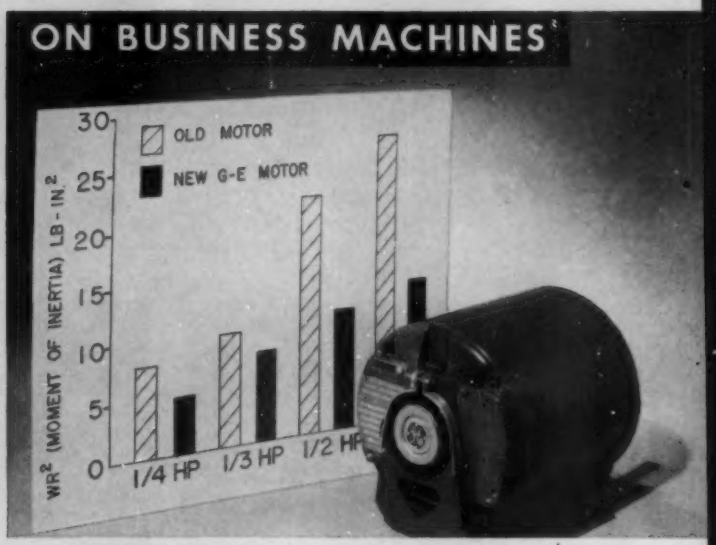
IMPROVE YOUR PRODUCT PERFORMANCE

ON MACHINE TOOLS



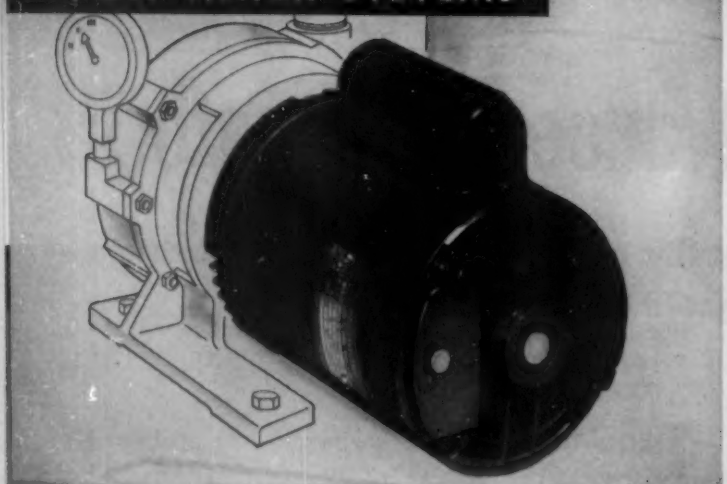
TEN-YEAR FACTORY LUBRICATION of G-E totally enclosed fan-cooled motors means extra-low maintenance. Special ball-bearing construction and new-type grease give long service, support heavy thrust loads. Welded-on base assures rigid mounting; compactness simplifies assembly and design. Rated ¼ to ¾ hp, 3-phase. Write for Bulletin GEC-1306.

ON BUSINESS MACHINES



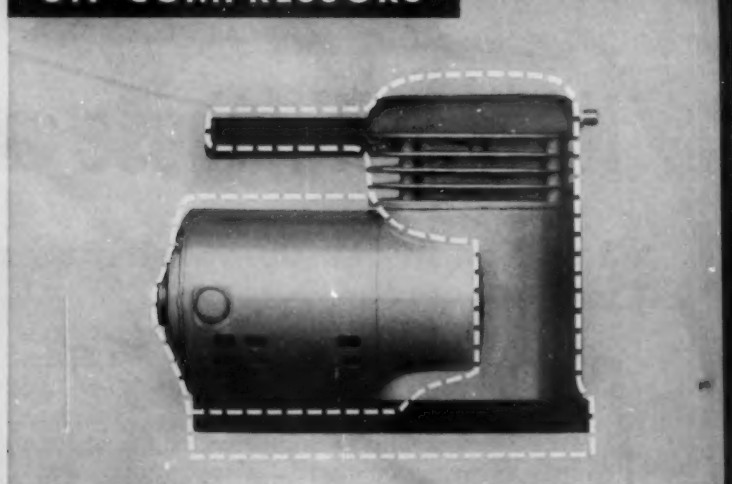
INSTANT MOTOR REACTION due to the low-inertia rotor makes smaller G-E fhp motors ideal for start-stop business-machine use. Absence of high-pitch noise in the magnetic circuit and vibration deadening effect of resilient mounting mean extra-quiet operation. Available in split-phase (Bulletin GEC-859) and capacitor-start (GEC-857) ratings from ⅙ to ¾ hp.

ON WATER SYSTEMS



EXTRA MOISTURE RESISTANCE is provided by modern insulation in this G-E jet-pump motor. Special under-water tests by G-E engineers prove Mylar* slot and between-phase insulation 35 times better than paper. New grease lasts 10 years, minimizes maintenance in hard-to-reach places. Ratings: ¼ to 1½ hp, vertical or horizontal mounting. Bulletin GEA-5902.

ON COMPRESSORS



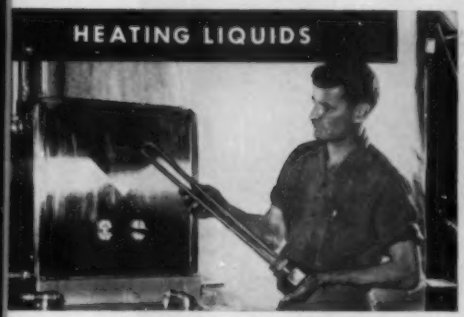
SMALLER SIZE of G-E fhp motors for compressors enables you to design more compact products. 40% lighter weight cuts your shipping costs. Two frame sizes cover entire line, permit you to standardize tooling, cut pulley stocks. A complete line of general-purpose and special-service ratings from ⅙ to ¾ hp is available. Bulletins GEC-854 and GEC-857.

***FOR FULL INFORMATION** on these and other G-E fhp motors, contact your nearby G-E Apparatus Sales Office. And write for Bulletins listed to General Electric Co., Sect. 702-21, Schenectady, N. Y.*

GENERAL ELECTRIC

DESIGNING HEAT INTO YOUR PRODUCT?

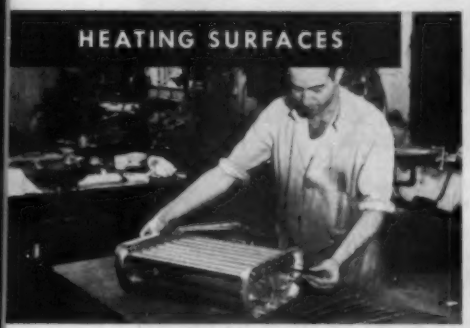
Complete† range of G-E Calrod* heaters gives you low-cost, functional design



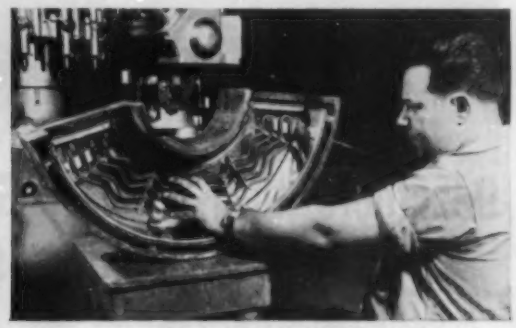
GENERAL ELECTRIC IMMERSION HEATERS, like the one used in this commercial washer, minimize heat losses through direct contact with the liquid.

EXTRA LONG LIFE is a big feature of this G-E immersion heater. Sealed terminals, high-grade resistance wire mean long, highly dependable service, low maintenance for milk pasteurizer.

EASILY FORMED General Electric Calrod tubular heater enabled this manufacturer to retain simplified, functional design of cement tester.



USE OF G-E SHEATH HEATERS in frankfurt grill, rather than ordinary open-coil construction, eliminates danger of oxidation and corrosion.



NEED FOR COMPACT, INTRICATE HEATER design meant G-E Calrod tubular heaters to the designer of this bottle-sealer. These heaters bend easily into an almost unlimited variety of shapes.

CONTINUED BREAKAGE of former heaters caused manufacturer of tire retreaders to turn to rugged, but flexible, G-E Calrod tubular heaters.

VERSATILE General Electric tubular heaters are easily formed to the shape of these hand dryers. Heaters are cast directly into dryer unit.

*Reg. Trade-mark of General Electric Company.

G-E TUBULAR HEATERS, installed inside this preheat oven, replaced outside, top-mounted heaters. Result—heating efficiency increased, power costs lowered, equipment made more compact.

GENERAL ELECTRIC reflector-equipped tubular heaters provide efficient, highly dependable heating for this high-production drying oven.

---

† ***FREE . . .*** 60-page Catalog of General Electric heaters and devices—describes full line. GEC-1005F

Section B723-3, General Electric Company, Schenectady 5, N. Y.

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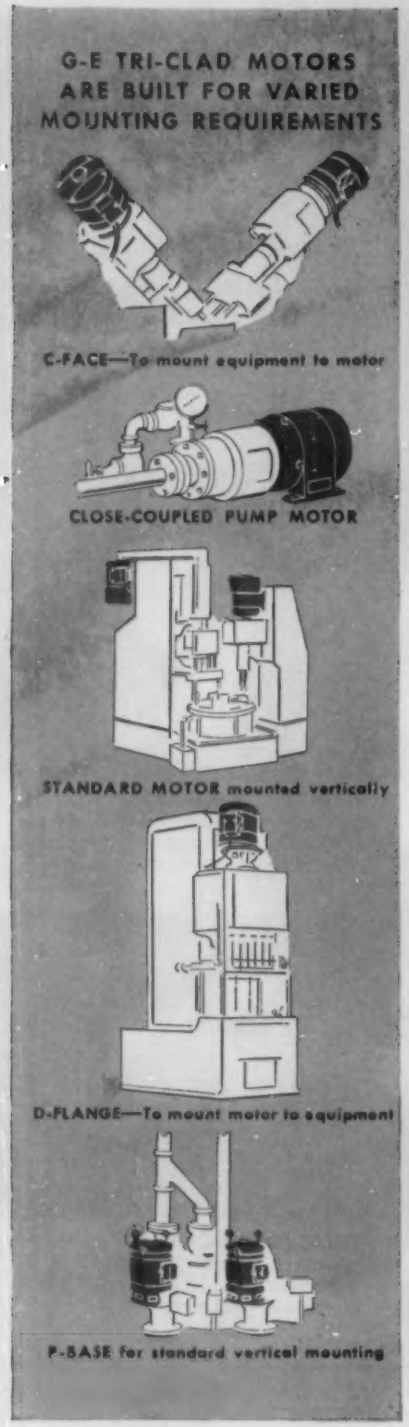
For more information, contact your local G-E Apparatus Sales Office

GENERAL ELECTRIC

Designer's

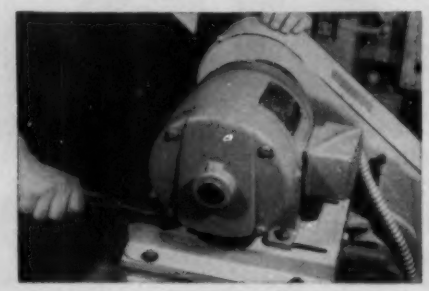


TEFC Tri-Clad '55' motors on drill and tap machine

Designers turn to new G-E TRI 55 CLAD in the big "motor switchover"

At General Electric, 291,745 manhours of research, engineering and development went into the new Tri-Clad '55' motors between World War II and the announcement of the new motor design in 1953. Just 2 years later, 70% of all G-E motors sold in the ratings in which new Tri-Clad '55' motors are available, are built to the new specifications. Progressive equipment manufacturers are switching to new G-E Tri-Clad '55' motors because they found that G.E., in addition to packing more power into each motor, had also added enormously to operating life and handling ease with features like: tough, new Polyester film slot and phase insulation; water-shedding stator windings; advanced bearing system which permits longer operation before regreasing is necessary; perma-numbered leads for positive identification; easy access conduit box with plenty of "knuckle room"; up to 40% smaller frames which reduce waste space without reducing active materials like magnetic steel and copper.

Bulletin GEA-6200 gives details.



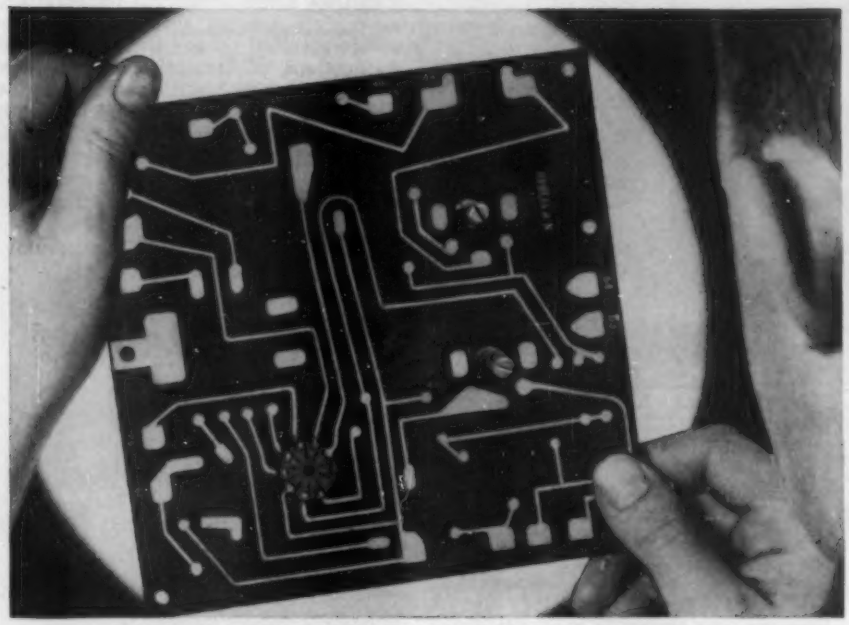
2 hp motor installs easily on lathe

5 hp, 1800 rpm motor on boring machine

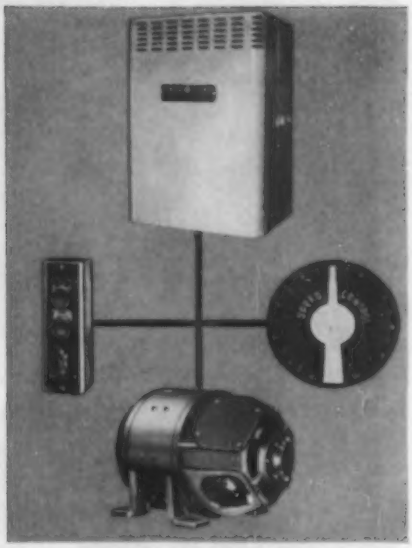
GENERAL ELECTRIC

Digest

MOTOR & CONTROL HIGHLIGHTS



REDUCED SIZE AND COMPLEXITY is printed circuits' design advantage.



THREE BASIC UNITS of new Thy-mo-trol drive are direct-current motor, push button station, and panel containing electronic tubes and "brain."

NEW "Printed-Circuit" Thy-mo-trol* drive gives adjustable speed at low price

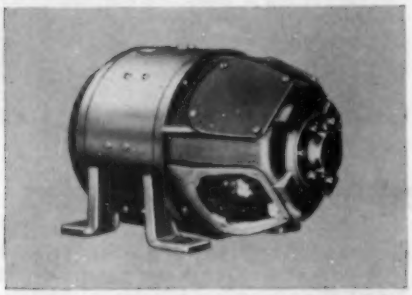
General Electric's Thy-mo-trol drive is now available in a simplified, low-priced design, ¾ to 3 hp. For design engineers this means substantial reductions are possible in weight, size, circuit complexity, wiring, maintenance costs, and installation costs.

The approximate 20% price reduction under the line it replaces was made possible by G.E.'s simplification of the entire control system, and adaptation of the printed control circuits into Thy-mo-trol panels. An electrical diagram is printed on the back of a sturdy, lightweight plastic board. The electrical circuits are made of solder-covered copper strips. All circuit components are connected without the use of wiring. All connections to the control circuits are of the simple plug-in type, making attachment and removal a simple time-saving hand operation.

Operating directly from a-c power, the new Thy-mo-trol drive includes electronic control panel, d-c motor, and push button station. The new drive is rated at constant torque over the entire speed range, which is 8 to 1 for continuous duty with higher ranges possible for special applications.

For information on designing this outstanding new adjustable-speed drive into your applications, see Bulletin GEA-6234.

*Reg. Trade-mark of G.E. Co.



Thy-mo-trol d-c motor has outstanding features for designers

The new Thy-mo-trol drive is outstanding because its components are outstanding. The d-c motor, for instance, is capable of great flexibility. Low-speed jogging for threading or positioning is easily obtained. Smooth, dependable dynamic braking reduces the use of friction brakes to holding function only. Uniform magnetic materials, dynamic balance, and low inertia permit the motor to respond quickly and smoothly to the electronic signal changes. Jig drilled feet provide uniform mounting dimensions, and external connections are made through generous conduit box which turns to any of 4 positions for convenience in connection. Foot holes are extended from frame to allow space for inserting holding screws.

General Electric Co., Apparatus Sales Division, Sec. A668-122, Schenectady 5, N.Y.

Please send me the following bulletins:

√ for reference purposes × for immediate project

☐GEA-6200 Tri/Clad Motors ☐GEA-6234 Thy-mo-trol

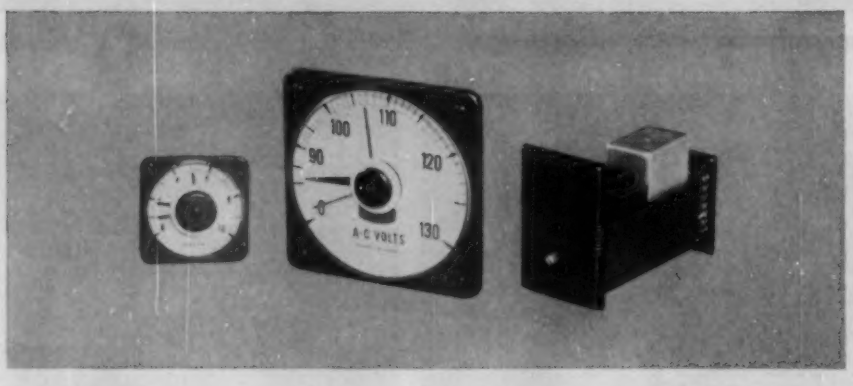
CONSULT YOUR SWEET'S PRODUCT DESIGN FILE. You'll find everything electric for machinery manufacturers in the General Electric Section.

NAME..... COMPANY.....

CITY..... STATE.....

TURN PAGE FOR MORE G-E PRODUCT HIGHLIGHTS

NEW G-E control initiating instruments provide dependable protection for heavy equipment



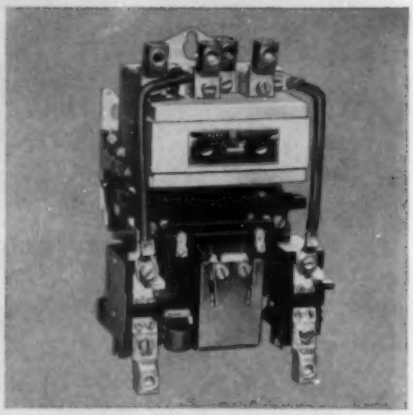
To shut down equipment at maximum speed point, to shut down equipment drawing more than normal power, to sound an alarm at critical temperature, to initiate control to hold frequency within specified range—these are typical applications of General Electric's new control initiating instruments. Available on either panel or switchboard instruments, the control-initiating feature provides contactless one- or two-set-point control, 1% accuracy, 0.1% repeatability, and immediate response, resulting in a system suitable for the most complex industrial applications. For more information, request Bulletin GEA-6325.

NEW latched-in relay is quiet, dependable control component

A new General Electric feature easily incorporated into your equipment, the mechanically held contactor and relay, will maintain continuity of sequencing in the event of power interruption. When power is restored after a failure, the operation of your machine will resume at that exact point in cycling where it left off. It is also used where quiet operation is needed, because the mechanical latch makes continued energizing of the coil unnecessary, which eliminates hum, and reduces heat. All terminals are front connected, giving ease of wiring, and the latching mechanism is operated by the famous G-E strongbox coil which helps protect the windings from mechanical damage. Bulletin GEC-1281 offers you complete information.

NEW NEMA 4 starter offers tremendous space advantage

Now General Electric has added a powerful new NEMA size 4 vertical lift starter, up to 50% smaller than the old design, to its complete line of magnetic starters. Installed from the front, it is completely accessible from the front when mounted. All the customer-proved features of smaller G-E magnetic starters, such as strongbox coil and permanent air gap, have been incorporated into it. Pressure type terminals are easily wired, located right up front, and 3 electrical interlocks, in any combination, normally open or normally closed, can be added from the front without removing the arc chute or movable contact assembly. A vertical or horizontal mechanical interlock is also available, for reversing or multi-speed controllers. Bulletin GEA-6322.



"Build-in" your product's heat with G-E Calrod* heaters

"WRAP AROUND" G-E Calrod tubular heaters bend easily for quick installation onto this extruder machine without danger of breakage.

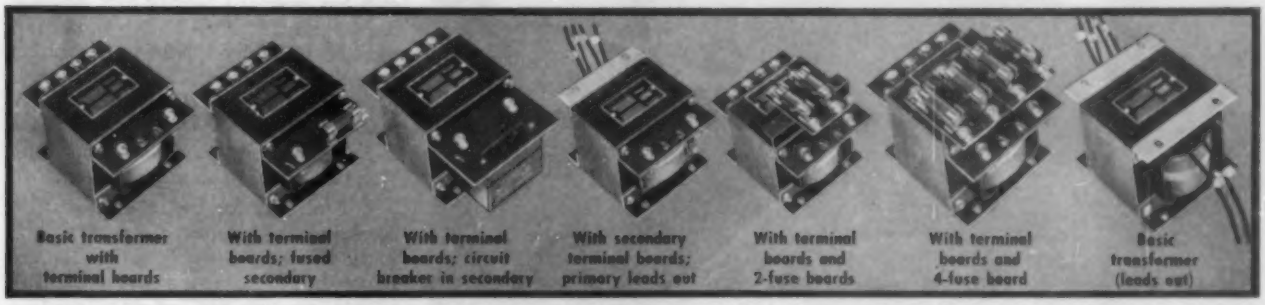
By using General Electric Calrod heating devices, designers can apply heat almost like a plastic, wrapping it, inserting it, clamping it, even casting it in. Regardless of the size or shape of your product, they provide clean, convenient, efficient heating. In heating liquids, for example, electric immersion heaters convey heat directly to the liquid. For surface heating, tubular units can be bent into intricate shapes for more efficient contact. For heating air, strip and Calrod fin units are easily installed in minimum space. Some of the successful applications of G-E Calrod units have been shrinking machines, package machines, extruders, fabric slitters, baking ovens, printing equipment, nylon setters, paint sprayers. For details, see your nearest G-E Apparatus Sales office or write for Bulletin GEA-5866.

*Reg. Trade-mark of General Electric Co.

GENERAL ELECTRIC

Designer's Digest

PRODUCT HIGHLIGHTS


Basic transformer with terminal boards
With terminal boards; fused secondary
With terminal boards; circuit breaker in secondary
With secondary terminal boards; primary leads out
With terminal boards and 2-fuse boards
With terminal boards and 4-fuse board
Basic transformer (leads out)

SELECT FROM SEVEN ACCESSORY GROUPS—OFFER CUSTOMERS A "SPECIAL UNIT" AT A STOCK PRICE

Pre-engineered control panels are custom-built to your needs

General Electric designs and tests these panels for your specific applications, which means you get a premium in the valuable engineering content "built in." This reduces the load on your own design and drafting staff, saves on inventory and storage costs of components. Assembly and wiring are already done. Neater, quicker and more flexible, trough wiring on many panels makes it unnecessary to untie the bundles of wires to make a change or addition. Only removal of the trough cover is needed. Contact your nearest G-E Apparatus Sales Office for complete information.

G.E.'s NEW family of compact machine-tool transformers mount easily, offer greater design flexibility

Now you can give your customer exactly the transformer he requires, from a new line of General Electric machine-tool transformers in basic standard ratings. They're available with fuses or circuit breakers, with or without terminal boards, as if you were offering him "special" units, but, at stock item prices.

Built specifically for machine-tool operation, their ease of mounting helps reduce installation cost, and low price helps keep over-all costs down. The wide rating range of the new units, which meet all NEMA and JIC standards, covers a hundred different machine-tool transformers. For full information about their specifications and unequalled flexibility, ask for Bulletin GEC-1270.

Versatile G-E amplidyne adjusts, limits, holds closely

Designers are using the General Electric amplidyne to control voltage, current, speed, power factor, or position. Basically, it improves and simplifies machine operation and increases production, with a unique use of a short circuit and compensating winding which creates such precise electrical balance that the smallest electrical signal releases kilowatts of output capable of controlling the most powerful machinery. Automatic, safe, precise, simple, flexible—the combination of these advantages makes it capable of phenomenal jobs, such as lowering a million-pound rotor assembly, or operating machine tools from templates, tapes, or punched cards. 24-page Bulletin GEA-4053B is in full color.

General Electric Company, Apparatus Sales Div., Sec. A668-123, Schenectady 5, N. Y.

√ for reference purposes X for immediate project

Please send me the following bulletins:

- ☐ GEC-1281 Latched-In Relays
- ☐ GEA-5866 Calrod Heating
- ☐ GEA-4053B Amplidyne
- ☐ GEA-6322 NEMA 4 Starter
- ☐ GEA-6325 Control Initiator
- ☐ GEC-1270 Machine-Tool Transformers

NAME .....

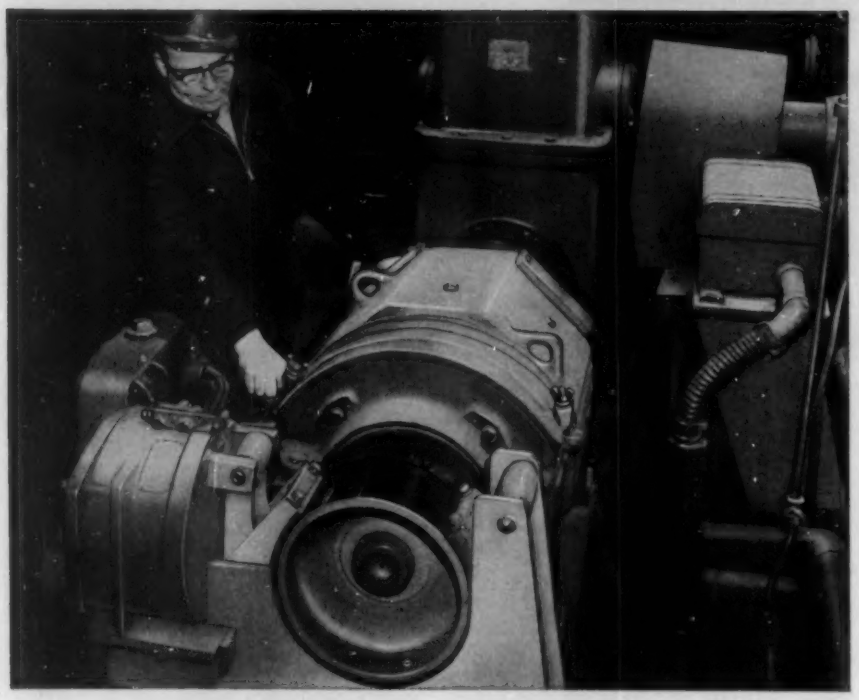
COMPANY .....

STREET .....

CITY ..... STATE .....

TURN PAGE FOR INDUSTRY CONTROL HIGHLIGHTS

NEW G-E d-c brake adjusted only once in eight months' 'round the clock operation

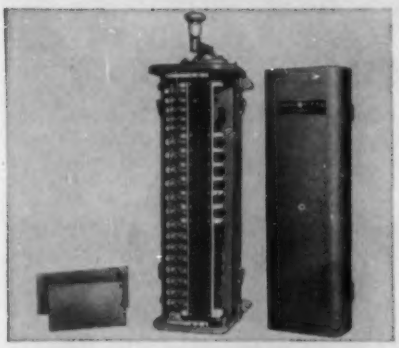


A new General Electric direct-current brake installed on a slab depiler in a steel mill has operated twenty-four hours a day for eight months with only the recommended normal adjustment for lining wear made at half million operations.

On the basis of this excellent performance the mill specified three more G-E d-c brakes for a slab handling crane which was recently installed.

The new brake has these features: single point adjustment, full rated torque in the worn-gap position, linings that are removable with only a wrench, easily visible armature-gap indicator, positive manual release, versatility of installation, all adjustments made at one end of the brake so only one end need be accessible, and is built to AISE standards.

This two-shoe, single-magnet brake establishes new standards for performance and easy maintenance on applications such as steel-mill drives, cranes, hoists, movable bridges, conveyors, and other applications requiring service continuity and low operating costs. **Write for Bulletin GEA-6214.**

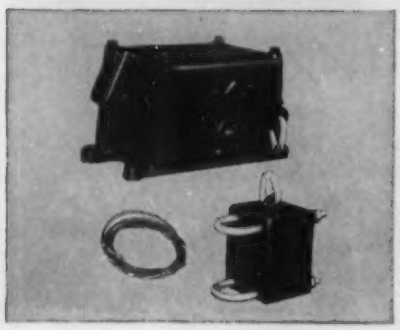


G.E.'s line of drum switches easily installed and maintained

General Electric offers a full line of drum switches for d-c motors and a-c applications of motor control. Conduit boxes are equipped with knockouts in bottom, back and sides for ease of installation.

Removable front covers (and back covers on larger units) provide plenty of room for wiring and easy access to working parts. Adjustments are readily made with minimum trouble and time.

Rugged reversible contacts give you double life, and reduced maintenance. Finger adjustments can be made with only a screw driver. Drum switch operating mechanisms are positionable in increments of 90° by simply relocating stop piece at top of unit. Standard horizontal handle is completely interchangeable with other operating mechanisms. **Write for Bulletin GEA-6307.**



G-E lever-type limit switches constructed for severe service

Double-break, lever-type limit switches manufactured by General Electric are constructed for tough applications. Many are designed for mounting within tight space limitations.

Track-type limit switches of cam-type construction are built for heavy-duty mill, and general service. Enclosed in a cast-iron case, weatherproof or waterproof types are available with several different types of levers.

For outdoor crane and hoist service, switches are made with weather-resistant enclosures. Extra corrosion protection is added for marine service units.

For operating protection on cable and drum equipment, a single-pole, double-break, slack-cable limit switch shuts down drive if a break or slack cable condition occurs.

GENERAL ELECTRIC

Designer's Digest

INDUSTRY CONTROL

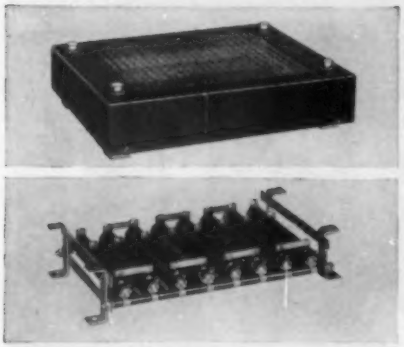
G-E dustproof master switches designed for tough applications

General Electric master switches, available with up to 12 circuits as standard equipment, are specifically designed for tough applications. Cam-operated and dustproof, they are ideally suited for use in steel-mill drives, crane hoists, electric shovels, and other materials handling applications.

These master switches have tough, tight-fitting cast aluminum covers that protect operating cams and contacts against dust, dirt, and possible damage due to external blows.

All three sizes of G-E master switches are actuated by cam assemblies made up of four, quarter cams. Position feel is adjusted by a star-wheel and pawl arrangement—operating pawl tension is varied by simply turning a nut. Stationary and movable contacts are easy to remove in a minimum amount of time without disturbing the wiring.

G.E. offers wide range of frame-mounted resistors

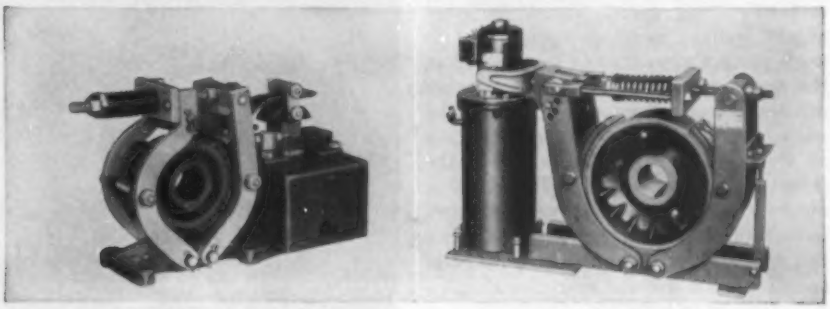


General Electric IC9133 frame-mounted resistors are built to withstand jolts and vibrations encountered in applications on traveling cranes, steel-mill auxiliaries, and other moving equipment.

Steel frames capable of taking rough treatment house individual resistor units, designated IC9033. Eight units, in longer lengths, can be included in one frame, stacking of frames is possible.

Mica tubes, which insulate resistor unit mounting rods from frame, give you double insulation to ground. Zinc plated mounting feet also available for independently mounting IC9033 resistor units, rated 1 to 96 amperes each. **Write for Bulletin GEC-1292.**

Get long service and low braking cost with G-E a-c brakes



SOLENOID BRAKE

THRUSTOR BRAKE

General Electric spring-set, two-shoe brakes, electrically released by solenoid or thrustor, are recommended for cranes, bridges, turntables, conveyors, and in machine-tool or other rotating equipment applications. These brakes are especially applicable where continuity of service and low braking cost are of importance.

G-E a-c brakes give you smooth, positive braking in either direction. Braking pressure is evenly distributed over entire lining surface by rigid mechanical construction. Brake shoes are self-aligning and there are only three simple accessible adjustments for torque, wear, and shoe clearance. **Write for Bulletin GEA-1518.**

General Electric Co., Apparatus Sales Division, Section A781-13, Schenectady 5, New York
Please send me the following bulletins:
For reference (×) For immediate project (√)

- ☐ GEA-6214 DC Brake
- ☐ GEA-1518 AC Brakes
- ☐ GEA-6307 Drum Switches
- ☐ GEC-1292 Resistors

NAME..... COMPANY.....

CITY..... STATE.....

SPEED VARIATORS CUT MACHINING TIME (TURN PAGE)

Designer's Digest

Flexible G-E Speed Variator Drives Save Machining Time, Provide Longer Tool Life

Provide constant surface cutting speeds for varying shape work pieces

GENERAL ELECTRIC PACKAGED SPEED VARIATORS can cut machining time as much as 47% when powering boring mills and lathes. They provide maximum constant surface cutting speeds for longer tool life, better surface finish and greater productivity.

LONGER TOOL LIFE—Carbide tools last longer if worked at the correct constant surface cutting speed. Speed Variators adjust spindle speeds automatically so work piece always travels by the tool at the same speed. As the tool approaches or moves away from the center of the work, a cam-operated reactor produces an electrical signal which is fed to the Speed Variator power unit. The Variator automatically adjusts the spindle speed to maintain the ideal cutting speed. Also, the operator can obtain a wide range of spindle speeds *without* gear changing.

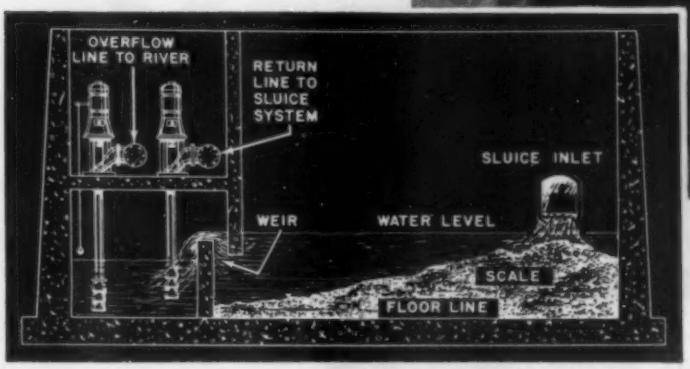
FACTORY-TESTED COMPACT DRIVES consist of: (1) Power unit housing conversion equipment in small, ventilated enclosure; (2) Operator's control station, with push buttons and rheostat that mount where convenient for operator; (3) Direct-current drive motors, whose inherent characteristics of constant torque or horsepower and low inertia make them ideal for machine-tool operations.

FOR MORE INFORMATION, contact your nearest G-E Apparatus Sales Office, or write for bulletin GEA-6127. Section 815-1, Direct Current Motor and Generator Department, General Electric Co., Erie, Pa.

LONGER TOOL LIFE... Lathe, machining turbine wheels, gives better performance since G-E Speed Variators maintain constant surface cutting speeds within narrow limits.

GENERAL ELECTRIC

Pumping Pit with Ingersoll-Rand vertical turbine pumps, heart of mill-scale recovery system at Allenport, Pa. plant of Pittsburgh Steel Corp. Two 6000 gpm units, in foreground, recirculate settled water. Smaller 3000 gpm pumps, at top, discharge overflow into river.



In Rolling Slabs at the hot strip mill, scale is removed from hot steel by water jets. Water carries the scale into a collecting tank. From the tank, a clam-shell bucket removes it to sintering plant. Steel content is used in blast furnaces, and stream pollution is reduced by the mill-scale recovery.

In mill-scale recovery

I-R Pumps of Stainless give 30 Times the Life

CORROSIVE ACTION of a notoriously unclean river . . . polluted with acid mine drainage . . . is defeated by these Ingersoll-Rand pumps.

Erosion is minimized, too. Erosion by abrasives in recirculated water of a millscale sluicing system. And erosion by hard, tough particles in water agitated by a clamshell used for scale removal.

That's why pumps of standard materials needed extensive repairs after only two months' use.

In contrast, chromium-nickel stainless steel units operated five years without replacements or loss in efficiency and performance.

Ingersoll-Rand pump specialists, metallurgists and engineers use these money-saving nickel alloys for impellers, casings, shafting, bolting and even for small interior parts of pumps in mill-scale service.

You, too, may set new standards of low-cost performance. Redesign to increase strength, yet reduce size and weight of your products or equipment, by using nickel alloys.

When you have a metal problem, let us help you. We'll give you suggestions based on wide practical experience. Take the first step now . . . write for "List A" of our available publications. With it comes a form for outlining your difficulties. Write today.

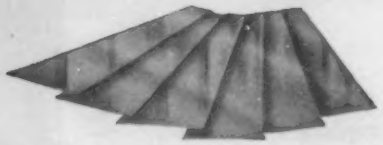
INCO TRADE MARK

THE INTERNATIONAL NICKEL COMPANY, INC. 67 Wall Street New York 5, N. Y.

save on Stainless Steel buying costs

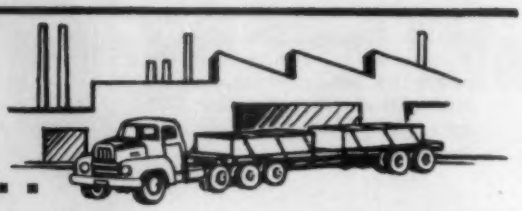
by reduced inventory

Your steel warehouse distributor keeps large stocks of stainless on hand. Buy stainless as you need it.



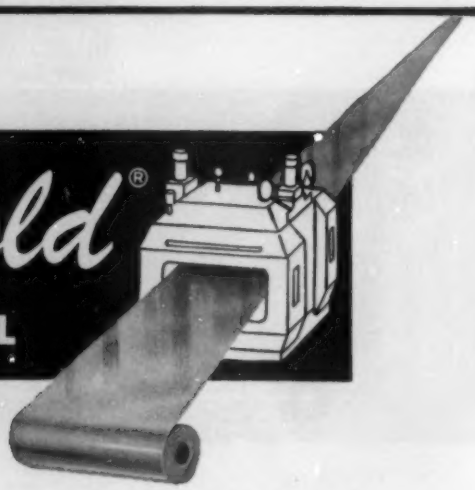
by faster service

Your steel distributor, being nearer to you, assures you of quicker deliveries to meet production schedules.



by specifying

MicroRold®
STAINLESS STEEL



with "Thinness Control"

MicroRold Stainless Steel Sheet is available through steel warehouse distributors strategically located at points most accessible to fabricators of stainless steel products. These distributors, being closely associated with the industry, not only facilitate the selection and delivery of stainless sheets but can also provide technical assistance on your stainless steel fabricating problems.

Your steel distributor will explain the advantages of buying MicroRold with "Thinness Control." This "Thinness Control" in the manufacture of MicroRold stainless sheets means the decimal thickness is uniform throughout the length and width. MicroRold is rolled to exceptionally close tolerances, as low as 3% average (plus or minus) as compared to the A.I.S.I. allowable of plus or minus 10%. Each .001″ in thickness saved results in a savings of 1.26 pounds when figured on a standard 36″x 120″ sheet. MicroRold's controlled accuracy of gauge gives you more stainless area per ton or the equivalent area with lesser weight.

Consult your nearest MicroRold Stainless Steel Distributor.
He will gladly tell you the MicroRold story.

WASHINGTON STEEL *Corporation*
Washington, Pennsylvania

Perspectives

DESIGN AND DEVELOPMENT

THE RARE EARTHS

The rare earths are not exactly rare, nor earths; in fact, they are found in greater abundance than such well known metals as tin and lead, and are as metallic as aluminum. But they have never found any great use in industry. In the period from 1945 to 1952 the production of rare earth oxides averaged only 3 to 4-million pounds per year. However, in recent years a rare earth alloy called mischmetal, has been found to be very effective in improving the properties of iron, steel, and magnesium. And today, the Atomic Energy Commission is faced with the problem of finding out just how detrimental the rare earths are in an atomic pile.

The rare earths, covering atomic numbers 57 through 71, have been allotted just one box on the periodic table, but spelled out they are: cerium, lanthanum, praseodymium, neodymium, promethium, samarium, thulium, europium, gadolinium, terbium, dysprosium, holmium, erbium, ytterbium, and lutecium. All of these elements are found as a group, never alone, in only two minerals that are commercially important for the production of rare earths and their salts. These minerals are Monazite and Bastnaesite. Rich deposits of Monazite are found in India, Brazil, Ceylon, and the Netherland India; in the U. S., the main sources are Florida and Idaho. Monazite contains about 65 per cent rare oxides. The main deposits of Bastnaesite, which contains about 70-72 per cent rare earth oxides, are California, and New Mexico.

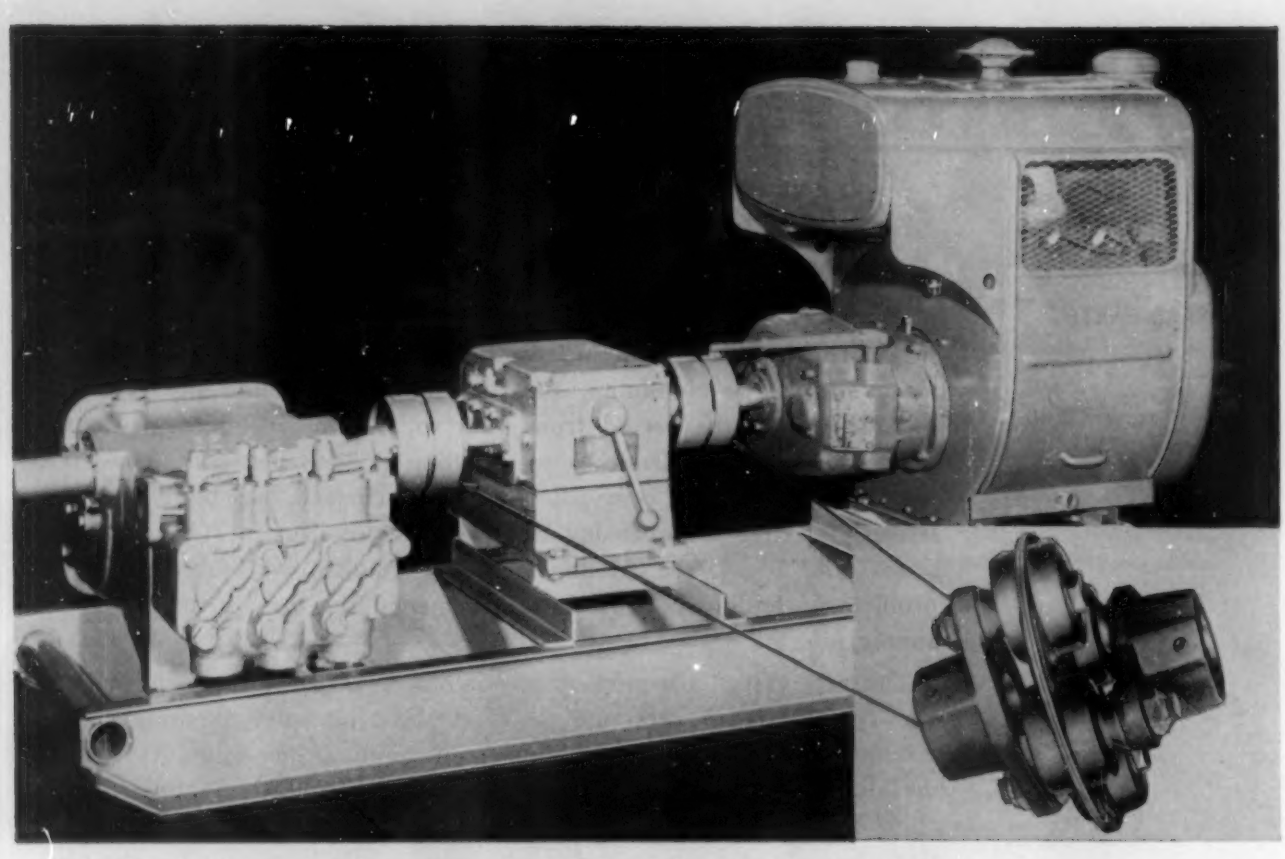
THE BREAKDOWN

While all of the rare earths are found in these two minerals, they are not found in equal quantities. Cerium is the most prominent one, making up 50 per cent of the total; Lanthanum is next with 25 per cent; Neodymium with 10 per cent; Praseodymium with 5 per cent; and all the rest one per cent or less. In the separation process used commercially, it is possible to get a relatively pure cerium, the main constituent of the mischmetal additive. Cerium oxide is good as a polish for optical glass, and can be added to a glass to prevent the passage of ultra-violet light.

MISCHMETAL ADDITIVES

The rare earths obtained from the monazite sand are in the form of oxides, which are processed to give rare earth chlorides. One pound of domestic rare earth chloride costs about fifty cents. In order to make one pound of mischmetal, four pounds of chloride are needed, immediately pushing the cost to $2.00 or more. Converting the chlorides to mischmetal is done by an electrolytic process, and with the large amount of power used, close supervision, and labor costs, the final cost of mischmetal is $4.00 a pound. The Molybdenum Corp. of America, a leader in the field of rare earth additives and owner of the large California bastnaesite deposit, claims that the addition of two pounds of their misch-

(Continued on page 125)



John Bean Core Drill Pumping Unit, Model 435CD, is a highly versatile machine used to flush diamond core drill cuttings from drill holes. In shaley structures, it can immediately be converted from mud to cement pumping. Its unique 3-speed transmission enables it to vary discharge capacity from 11 to 35 GPM, at pressures from 300 to 700 PSI.

The compact coupling arrangement enables the complete pump assembly to be mounted on one skid, greatly facilitating erection, disassembly, and transportation.

Morse Morflex Couplings (shown at right without safety covers) are ideally suited for a job such as this. They are flexible; are capable of transmitting power smoothly, absorbing variant shock loads, and compensating for severe torsional and dimensional misalignment.

Morse Morflex Couplings prove their dependability in new pumping unit

Morse Morflex Couplings were specifically designed to meet machine requirements such as those of the John Bean Core Drill Pumping Unit.

Morse Morflex Couplings do not require lubrication and maintenance, because there are no moving parts to wear. They accommodate all conditions of misalignment and torsional load vibration by elastic deflection of neoprene biscuits. They are impervious to water, dirt, oil, and weather conditions; they are compact, and dependable.

Morse Morflex Couplings offer smooth, vibration-free power transmission without undue thrust loads on the drive shaft bearings. Shock loads are cushioned, bearing life prolonged, and quiet operation is assured. And most important—downtime is reduced to a minimum!

Investigate the many advantages of using Morse Morflex Couplings, as well as other Morse precision-built power transmission products, on your equipment: Morse Roller Chain, Sprockets, Roller and Silent Chain, Couplings, Cable Chain, and Clutches. MORSE CHAIN COMPANY, INDUSTRIAL SALES DIVISION, ITHACA, NEW YORK.

MORSE

BW

CHAINS, CLUTCHES, AND COUPLINGS

metal compound to each ton steel will increase the yield to 82 per cent, as compared to 78 per cent without the additive. This increased yield is brought about by the improved hot workability of the steels, particularly in the rolling process where edge cracking is reduced. Other effects of rare earth additive on cast-iron, stainless steels, magnesium, and aluminum are high temperature creep resistance, better casting and extrusion properties, and better low temperature impact strength.

Even so, mischmetal is still considered a costly alloy material, and is not too widely used, as evidenced by 100,000 pounds per year used for this purpose. Cigarette lighter flints still take most of the 500,000 pound annual production. Larger demand, of course, should help to reduce processing costs, and further research should find a cheaper form of rare earth material. Rare earths in the oxide form has been suggested.

A BETTER SEPARATION PROCESS

Many people feel that the only way to attack the rare earth problem is to find a more economical way to separate each of the 15 elements. Some companies have accomplished this in their laboratories, but still get only extremely small quantities, so that on a pound basis, the cost would be in the thousands of dollars. Dow Chemical Co. has been successful in getting small quantities of some of the individual elements, and have been testing their effect on magnesium. So far it has been found that the neodymium and praseodymium that remain when the other metals are removed from mischmetal, adds to the strength and creep resistance characteristics of magnesium-rare earth alloys in temperatures up to 500 F.

The U. S. Bureau of Mines will spend a sizable amount on rare earth research in 1955, and expects to increase the expenditure in 1956. The Army is also financing a study to gather data on the effects that the various rare earth additives have on steel melts.

ATOMIC ENERGY AND THORIUM

The reason why the rare earth industry is so small is that not enough companies have devoted research to it. This was true until it was learned that rare earths were being found as by-products of atomic fission. It was learned that they, gadolinium in particular, were good absorbers of neutrons, and slowed down uranium reactors. Consequently, many of the people interested in the rare earth industry are now waiting for the Atomic Energy Commission to find a way of separating all of the elements.

What could change the entire picture is the effect of thorium on the atomic energy program. Thorium too, is found in monazite sands in quantities ranging from 5 to 15 per cent. Thorium is not fissionable, but tests have indicated that if it is put into the reactor with Uranium-235, a chain reaction converts thorium to another fissionable element called U-233, which can be used as fuel. Also, it has been mentioned that U-233 is just as effective in the atomic bomb as U-235, and plutonium.

Thorium is more abundant than uranium, and is easier to handle than plutonium. This, plus the announcement by Battelle Institute that they have developed a simplified process for recovering thorium, could increase the thorium market, and make rare earths an inexpensive by-product.

Speed Nut Savings Stories

This one SPEED NUT for either screw provides new savings!

If you use "A" and "Z" sheet metal screws in your product assemblies, here's good news for everyone from your design and production engineers to stock room clerks.

C7000 Flat Type SPEED NUTS work equally well on both "A" and "Z" sheet metal screws—only one type of SPEED NUT brand fastener to purchase, stock and handle. You reduce inventories, eliminate parts mixing. And you can also lower unit costs through larger quantity purchases.

One SPEED NUT replaces three parts . . . lock washer, threaded nut and spanner washer. Yet it offers an attachment that is permanently tight until you want to loosen it!

Ask your Tinnerman representative for samples of the new dual-service C7000 Flat Type SPEED NUT . . . it's the modern way to save time and money, and avoid headaches!

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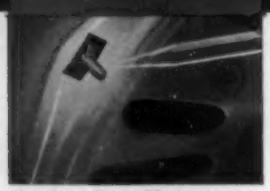
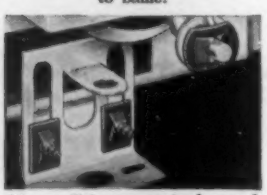
TINNERMAN Speed Nuts® FASTEST THING IN FASTENINGS®

TYPICAL USES



Flat Type SPEED NUTS cut costs of attaching auto radio speaker to baffle.



Air-conditioner control-panel assembly costs cut 40% with help of Flat Type SPEED NUTS.

Special Flat Type SPEED NUT reduced assembly time 87% on washer motor mount bracket.

More than 8000 shapes and sizes

Too Much Pressure

MOST EXECUTIVES UNDERSTAND the impossibility of perpetual motion. Yet only too often they demand equally impossible performance from their engineering department. They refuse to admit that there are any limitations in engineering design, either quantitatively or qualitatively. These are the high pressure executives who seem to think that all they need do is to demand and it shall be given.

One frequently hears an executive boasting that if he had not insistently demanded a stated performance, from the engineering department, that department would not be nearly so productive. They seem to think it is only their bellowing that makes the engineering department productive. In fact, such company executives are a menace.

Recently at a dinner given to celebrate the successful completion of a new design and its successful test and tryout, one of the top sales executives of the company chestily told the audience that he was the man who had designed the machine and that the engineering department had merely drawn "the pictures" as he called them. Actually, this man was incapable of making the most elementary engineering calculations, was completely ignorant of materials properties and their significance and knew nothing about mechanics, electricity or hydraulics. Yet in the presence of his engineering executives he boastingly claimed all the credit for the new development.

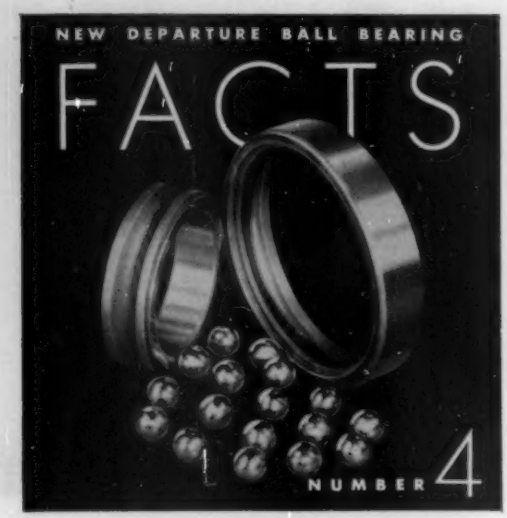
Another angle of this same situation is the company executive who is forever needling the engineer. He has little regard for the truth and makes false claims that he cannot substantiate. As a result of all this loose and irresponsible talk by the company executive the engineers are compelled to waste a great amount of time running down the false leads and gathering data and information to prove that the claims of the executive are erroneous.

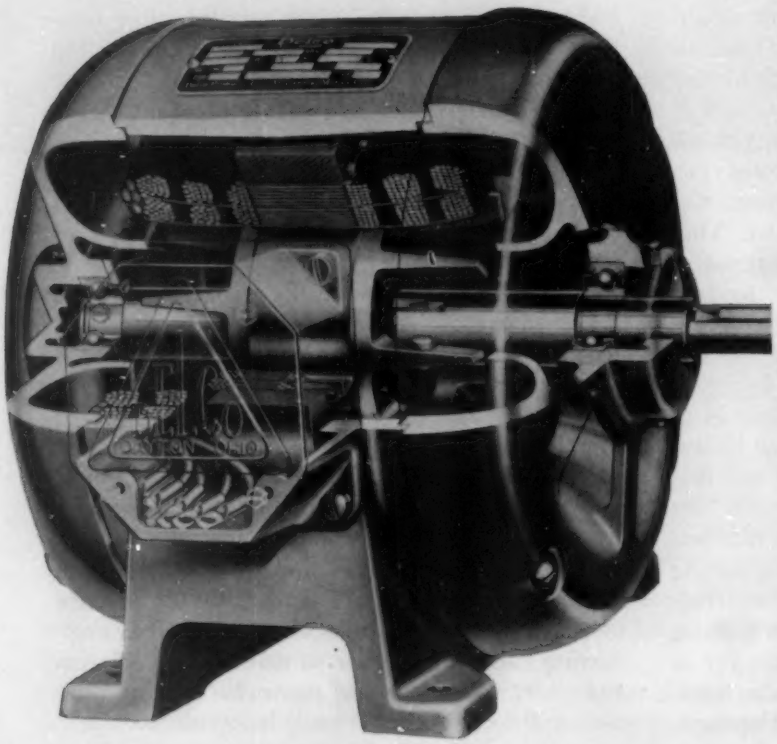
When the engineering is treated as a responsible body and is not compelled to waste its time combatting unintelligent demands and assertions of top executives who know nothing of engineering, the engineering department is able to concentrate on the problems at hand. The men have time to think and to make their design analyses complete and thorough. They have the time to establish facts instead of making their decisions on the basis of opinions.

One can never prove what the product might have been had the engineering department been permitted to do a complete and thorough job. There is absolutely no way of proving what the result might have been had the engineers been given time to think. The price of pressure cannot be expressed by a number preceded by a dollar sign. But it is safe to say that design productivity is greatly increased, and the quality correspondly so, when the engineering department is allowed a reasonable time to develop their design, and without the interference of other company executives who consider their engineering judgment superior to that of the engineers and their opinions beyond reproach. Putting pressure on the engineers can easily be overdone.

George F. Rockwell

Answering the need for VERSATILITY in electric motors!





This Delco general-purpose, drip-proof motor is equipped with New Departure self-enclosed ball bearings. They not only assure permanently accurate support of the rotor shaft under all load conditions, but in normal operation they reduce bearing lubricating requirements to just about zero. However, should extra-severe conditions warrant it, the lubricant can be replenished quickly by removing the pipe plugs.

Note that the bearings have built-in seals on the inside faces, thereby preventing grease leakage into the motor, and the outer faces have metal shields which keep foreign matter out of the bearings. The shields do, however, permit entry of just the right amount of grease from the space in the end bell for perfect bearing operation, yet prevent excessive lubrication which could cause overheating.

End applications for modern electric motors are extremely varied. They may be mounted in positions from horizontal to vertical. Radial and thrust loads may be encountered in numerous combinations. Mounting locations may make periodic lubrication difficult or costly. Atmospheres may be charged with abrasive dust, or extreme cleanliness may be mandatory, with no lubricant leakage allowable.

All these conditions are directly related to the motor bearings—in fact *the versatility of a motor, or its ability to meet them, depends on the bearings used.*

BALL BEARINGS ARE THE ANSWER

Among the important features of the ball bearing are its ability to resist loads imposed from any direction and to locate rotating parts accurately and positively for many years of service. In electric motors accurate rotor-to-stator relationship is maintained regardless of mounting position, and bearings are cool-running at all speeds.

Lubrication factors are important too. Motors equipped with New Departure self-sealed or shielded bearings may be installed in difficult-to-reach places because the bearings will operate for years under normal conditions without attention for lubrication or adjustments of any kind.

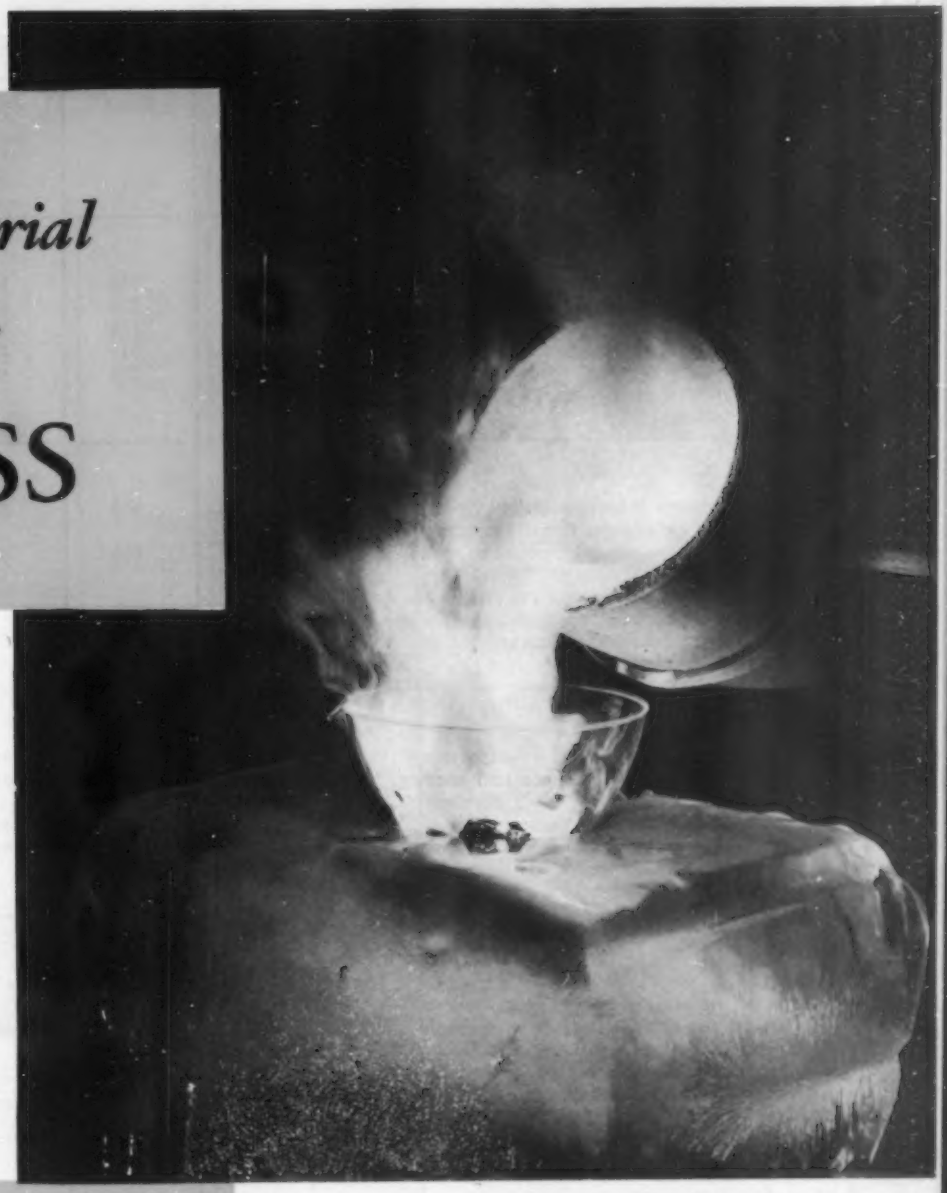
With New Departure self-sealed, grease-lubricated ball bearings, lubricant leakage is no problem and the bearings are fully protected from abrasive dirt.

Just as New Departure has pioneered bearing developments which have added so greatly to the versatility of today's electric motors, so will New Departure be first with the bearing advances of tomorrow. New Departure, Division of General Motors Corporation, Bristol, Connecticut.

NEW DEPARTURE
BALL BEARINGS

NOTHING ROLLS LIKE A BALL

New Industrial Uses for GLASS



96 per cent silica glass is one of the most significant developments in the history of glassmaking. It is chemically stable and can be subjected continuously to temperatures up to 1800 F without melting, cracking or otherwise deteriorating. This shows molten metal being poured into a 96 per cent silica glass dish which rests on a cake of ice.

Transparency is only one property of glass, often incidental in engineering applications. Corrosion resistance, dielectric strength, elasticity, moldability low thermal conductivity and surface quality are other properties which make glass an important engineering material. Physical properties are tabulated for 5 types of glasses including the new 96 per cent silica composition for high temperatures.

R. L. CALLARD
Corning Glass Works, Corning, N. Y.

THE WORD "GLASS" covers a wide variety of compositions. Tens of thousands of glass compositions are on record and the properties of glasses vary over a wide range. The properties of a 96 per cent silica glass compare with those of a soda-lime type window glass as platinum compares with cast iron. Transparency is usually considered the chief property of glass, while other properties important to industrial product design are ignored.

There is a wide variation in the properties of various glasses but certain general properties can be considered common to most glasses.

A discussion of the chemical corrosion of glass

Table I—Properties of Glasses

	Viscosity Reference Points, deg C				Specific Gravity	Expansion Coefficient (Per C) $\times 10^7$ (0 to 90 C)	Young's Modulus psi $\times 10^{-6}$
	Working Point	Softening Point	Annealing Point	Strain Point			
BOROSILICATE GLASSES							
Borosilicate glasses are characterized by high thermal endurance, high softening point, high chemical resistance and excellent electrical stability. Typical applications: ovenware . . . coffeemakers . . . laboratory ware . . . electrical insulation . . . guage glasses . . . industrial piping	1220	820	555	515	2.23	32.5	9.7
		775	524	486	2.24	36	
	1110	755	518	484	2.35	36	9.5
	1210	780	515	475	2.23	34	9.1
	1200	915	712	672	2.53	42	12.7
HIGH SILICA GLASSES							
High silica glasses are characterized by extreme thermal endurance, very high softening point, high chemical resistance and excellent electrical stability. Typical applications: range burner plates . . . crucibles . . . ultraviolet lamps . . . thermocouple protecting tubes . . . induction furnace linings . . . electrical insulation.		1500	910	820	2.18	8	9.5
		1500	910	820	2.18	8	9.5
OPAL GLASSES							
Opal glasses are characterized by a uniform and well controlled translucence and good mechanical strength. The glass numbers listed offer a wide range in degree of translucence. Typical applications: lighting ware . . . bowls for electric foodmixers . . . food service dishes . . . refrigerator storage dishes.		775	531	499	2.58	80	
		768	529	496	2.65	69	
		705	519	489	2.52	81	
		672	475	445	2.63	87	
LIME GLASSES							
Lime glasses are characterized by careful control of mechanical properties as well as excellent visual qualities. Typical applications: incandescent lamps . . . tumblers . . . vacuum bottles . . . fluorescent lamps . . . tableware . . . refrigerator trays . . . washer windows.	1000	696	510	478	2.47	92	9.8
		710	503	470	2.40	82	
LEAD GLASSES							
Lead glasses are also characterized by careful control of mechanical and electrical properties and high visual quality. Typical applications: stems for incandescent lamps . . . level vials . . . fuses . . . lampworked novelties	970	626	428	397	2.85	91	9.0
	975	630	433	400	3.05	89	

can be very simple. Glass is attacked by so few reagents that it is measurably affected only as follows:

Hydrofluoric Acid—Serious corrosion

Hot Concentrated Phosphoric Acid—Serious corrosion

Alkaline Solutions—Cold alkaline solutions, dilute or concentrated, attack glasses very slowly, but as temperature is increased the rate of corrosion rises rapidly.

Superheated Water—Although glass is attacked by water at elevated temperatures (over 300 F) the rate is rarely high enough to prevent satisfactory service life of such parts as high and low pressure boiler gages. Attack increases with temperature and alkalinity of the water.

Borosilicate glasses and high silica glasses are more resistant to most forms of chemical attack and, generally speaking, they should be used where this is a problem.

Controlled Transparency

In addition to high transmission of electromagnetic energy within the range of the visible spectrum, some glasses transmit light in the ultra-violet region having wave lengths as low as 0.22 microns. Others can pass infrared

Electrical Properties					Refractive Index $\lambda = 589m\mu$
Volume Resistivity log P (ohm-cm)		Dielectric Properties 1 mc @ 20 C			
250 C	350 C	Power Factor	Dielectric Constant	Loss Factor	
8.1	6.6	0.0046	4.6	0.021	1.476
8.2	6.7	0.0028	4.7	0.013	1.475
8.8	7.2	0.0027	4.7	0.013	1.487
9.4	7.7	0.0018	4.5	0.0079	1.473
11.4	9.4	0.0037	6.3	0.023	1.534
9.7	8.1	0.0004 0.0006	3.8	0.0015 0.0023	1.458
11.2	9.2	0.00024	3.8	0.00091	1.458
					1.507 1.508 opaque 1.513
6.4	5.1	0.009	7.2	0.065	1.512 1.496
8.9	7.0	0.0016	6.6	0.001	1.539
10.1	8.0	0.0016	6.6	0.001	1.560

waves as high as 4.5 microns, and intermediate ranges can be selected through proper choice of composition. Most of the products relying on this property are optical in nature; lenses, lighting bowls, and signal ware are examples.

Electrical Properties

Glass is widely used in the electrical industry for insulators, incandescent lamp and electronic tube components, electronic components, neon sign tubing, sealing heads, and fuse bodies. A list of glass properties which make it desirable for these purposes are high dielectric strength, high volume resistivity, good surface resistivity and hard smooth surfaces that do not become conducting under the action of arcs, and low power factor and loss factor.

The dielectric strengths of the usual glasses are so high (3100 to 5000 KV/cm at room temperature) that actual data need not be considered in design. For most commercial insulation the thickness of the glass necessary for mechanical considerations is far in excess of that necessary to prevent dielectric breakdown.

Volume resistivity of glass is on the order 10^{12} to 10^{18} ohm per cm. This decreases rapidly with temperature rise.

Surface resistivity depends more upon the surface films than on the composition of the glass itself although the borosilicate glasses usually allow higher surface resistivity than lime glasses. A film of moisture will reduce resistivity quite seriously and the presence of dirt or dissolved gases in the film will cause an even further reduction. This effect is greatly reduced if the glass surface is treated with water repelling silicones so that the moisture forms into droplets rather than a continuous film.

Several glasses with exceptionally low power factors have been developed in recent years. These glasses all have power factors of less than 0.1 per cent at room temperature and 1 megacycle. There is relatively little increase until the temperature exceeds 100 C.

Mechanical Properties

Glass, like other ceramics, is a brittle material. It does not plastically deform before failure and it fractures only from tensile stresses, never from shear or compression. The stress strain curve for glasses is a straight line up to the breaking point.

The intrinsic strength of all glasses is extremely high, possibly as much as 3,000,000 psi. The useful strength of glass is a small fraction of that because of stress concentrations due to surface imperfections. A rod of glass with perfect surfaces may be as strong as steel, but normal handling produces surface stress raisers that will limit its ultimate strength to about 10,000 psi.

When an adequate safety factor is provided, maximum working stress for annealed glass is taken as 1,000 psi, and for tempered or heat treated glass as 2,000 to 4,000 psi depending on the piece in question. Tempering is heat treatment given to the finished piece to set up controlled compressive stresses on the surfaces and balancing tensile stresses in the center layer. Its effect is to increase mechanical strength by 100 to 400 percent.

The strength of glass does not vary greatly from one

composition to another. However, most borosilicate glasses resist scratching and usually give better mechanical service.

The compressive strength is high; of the same order as cast iron. The modulus of elasticity ranges from about 9,000,000 psi to 12,000,000 psi depending on composition, or around the same valves as aluminum and brass.

In all glass designs, consideration must be given to the unusual combination of high elastic modulus and relatively low tensile strength. Here are some other characteristics which are interesting:

Perfect Elasticity. For all ordinary purposes, it can be assumed that glass is perfectly elastic up to the point of fracture. There is practically no mechanical hysteresis. This property is utilized in some instruments using glass helical coil springs.

Hard Surface. Glasses can be scratched by agate, sand or hardened steel, but not by mica, copper, aluminum, or mild steel.

Smooth Surface. Glass articles exhibit almost total freedom from polish marks. It is sub-cooled liquid at operating temperatures so that surfaces are smoother than the molds from which the article is produced. Drawn tubing surfaces have the greatest possible freedom from surface roughness, since no dies or mandrels touch it as it is formed. This characteristic minimizes tendency to foul or scale.

Moldability. Glass parts can be pressed or blown in molds on automatic machinery. Hence, complex shapes can be economically produced. Tubing is machine drawn by the Danner process where hot glass is poured onto a slowly revolving mandrel and slides off the end in tubular form.

Low Thermal Conductivity. Thermal conductivity of glasses average about 2 per cent of the rate for iron, or 1 per cent the rate of aluminum.

Temperature Resistance. Common window and container glasses can be used up to 750 F. However, where temperatures above 125 F are involved, a glass should be selected which has adequate resistance to thermal shock. Borosilicate, heat resistant glasses are unchanged when held indefinitely at temperatures up to 950 F.

Dimensional Stability. All glasses are characterized as having absolute dimensional stability.

Low Thermal Expansion. Most glasses expand at a rate lower than steel. Window glass is about 80 per cent, borosilicate heat resistant glass about ¼, and quartz about 5 per cent. This factor should be taken into account in designing glass-to-metal assemblies which will operate over a wide range of temperatures.

Impermeability. Regardless of temperature, glasses are not porous; consider the electric light bulb.

In examining some cases where design problems have been solved by using a material having a combination of these properties, it is noted that, in every case, three or more of these basic properties are required.

Godet Wheel

A design problem solved by the use glass is found in the godet wheel used in rayon machines. Viscose, a solution of cellulose in a mixture of carbon disulphide and sodium hydroxide is extruded through a spinnerette into a solution of sulphuric acid. This coagulates the cellulose in the form of a simple yarn composed of as many as 800 fine filaments. These delicate, freshly-formed yarns must then be pulled up out of the acid solution, washed and stretched. This is done by two godet wheels in series, the first pulling up the yarn and snubbing it (the strand is double wrapped) while the second wheel traveling faster, induces the stretch. A stream of hot wash solution runs over the first wheel to remove the acid.

Here are the design characteristics which the godet wheel material must meet. There is no need for high tensile strength for there is little tension on the wheel. Dimensional stability, however, is very important for if the wheel were swelled by acid, the change in peripheral velocity would affect the yarn stretch and distortion or wobble would put a wave in the tension values.

Moldability is necessary for the fluted shape is complex and large numbers of the wheels must be produced at a reasonable cost. Some resistance to temperature is necessary because of the hot wash water and chemical corrosion resistance is equally important as the yarn carries dilute H_2SO_4 from the coagulating path. There is some abrasive action by the yarn, so the surface must be relatively hard and, because delicate filaments at this stage are easily damaged and frayed by the slightest surface imperfection, the surface must be absolutely smooth. Glass is the one material which fulfills all the requirements.

Fuse Plug

The household electrical fuse plug is a product which makes use of some of the properties of glass. The dimensional stability of the material keeps the plug from sticking in the socket when the fuse box is humid. Corrosion resistance enables it to withstand dampness and the fact that it is a non-conductor makes it safe. The transparency of the glass permits visual inspection of the fuse, while the ease with which the material may be molded allows low-cost production of the unit complete with a screw thread and a knurled top.

Variable Orifice Type Flowmeter

This flowmeter is a product that takes advantage of a number of glass properties. It is a device for measuring instantaneous flow of fluids and consists essentially of a tapered, calibrated glass tube and a metal float. The unit is mounted vertically, with fluid flowing upward through it.

The float must have a constant diameter and weight. As it rises in the tapered tube, the space between the float and the tube increases, thereby passing fluid at a higher rate. The height of the float indicates the instantaneous flow rate, and calibrations on the outside of the tube can be read against an indicator on the float.

The advantages of glass utilized in the manufacture of this unit are transparency, surface smoothness as eddy currents at the inner surface would reduce accuracy, moldability, heat resistance, absolute dimensional stability and chemical resistance.

The method used in producing the flowmeter is a process in which glass tubing is sagged onto a steel mandrel, therefore, the glass used must have an exceptionally low thermal coefficient of expansion. This permits withdrawal of the steel mandrel after the forming operation.

Glass Pipe

The chemical and food industries use glass pipe in diameters from 1 in. to 6 in. Here the primary requirement is chemical resistance in handling all types of acids and solvents with the exception of hydrofluoric acid. Surface smoothness is exceptionally important in food and milk plants since the pipes must be frequently cleaned.

Transparency helps plant operators to establish accurately the progress of material through the pipes and to determine the cleanliness of the inner surface.

In electrolytic chlorine cell piping, it is important that pipes be non-conductors of electricity. Since the piping is machine drawn, the cost is reasonable. Heat resistance is also important for glass pipes are sometimes required to carry fluids at temperatures up to 450 F.

Design Considerations

Most glass design requirements can be met by four basic forms of glasses; pressed ware, blown ware, drawn, and sheet. Not all glasses are available in the four basic forms, but suitable substitutes usually can be suggested and used with complete satisfaction. These forms are available in the 5 compositions listed in Table I.

Other shapes and sizes can be manufactured by combinations of several of the basic forms. Glass parts can be sealed or welded together as easily as metal or plastic parts. Many glass products that could not be formed in one piece are made by sealing various components together. Pipe is made by sealing flanges to long lengths of tubing. A lamp worker makes complicated apparatus by sealing hand worked components together. The upper bowl of a vacuum coffee maker is an example of two different forms of glass sealed together. The bowl itself is fabricated from a blown blank and the long slim stem which makes blowing in one piece undesirable is a length of tubing.

Cold glass cannot be shaped with a cutting tool. Some special drilling operations are possible, but these must be considered as something of an exception. The material can be ground and lapped and it can be polished to a smooth surface. Tubing and rod can be cut by a variety of simple "crack-off" methods. Heavy pieces of glass can be sawed with abrasive or diamond wheels. Holes can be formed in glass by font molding, where the glass can be forced around mating core-pins. They are usually made by drilling or grinding off molded boses. It is advisable to avoid holes in glass parts if the same results can be obtained without them, as they usually make an appreciable addition to manufacturing cost.

Glass and Metal Assemblies

Mechanical clamping is the most common method of combining glass and other materials. There are a number of factors which must be kept in mind when designing clamped joints for glass parts. The forces used in holding the parts together should apply predominantly compressive stresses to the glass. Avoid heavily loading the glass parts in bending, tension or shear. Resilient pads or gaskets should be placed between all glass and metal surfaces to avoid concentrated stresses.

If compression stresses are applied to a flange on the glass part, the flange should be designed to avoid bending stresses and should be strong when compared with the non-glass parts of the assembly. All fitters should be mounted outside the glass part. There should be no bolt holes or bolt notches in the glass flange. The clamping ring should be sufficiently stiff so that it will not deflect and cause localized stresses in the glass. The number and

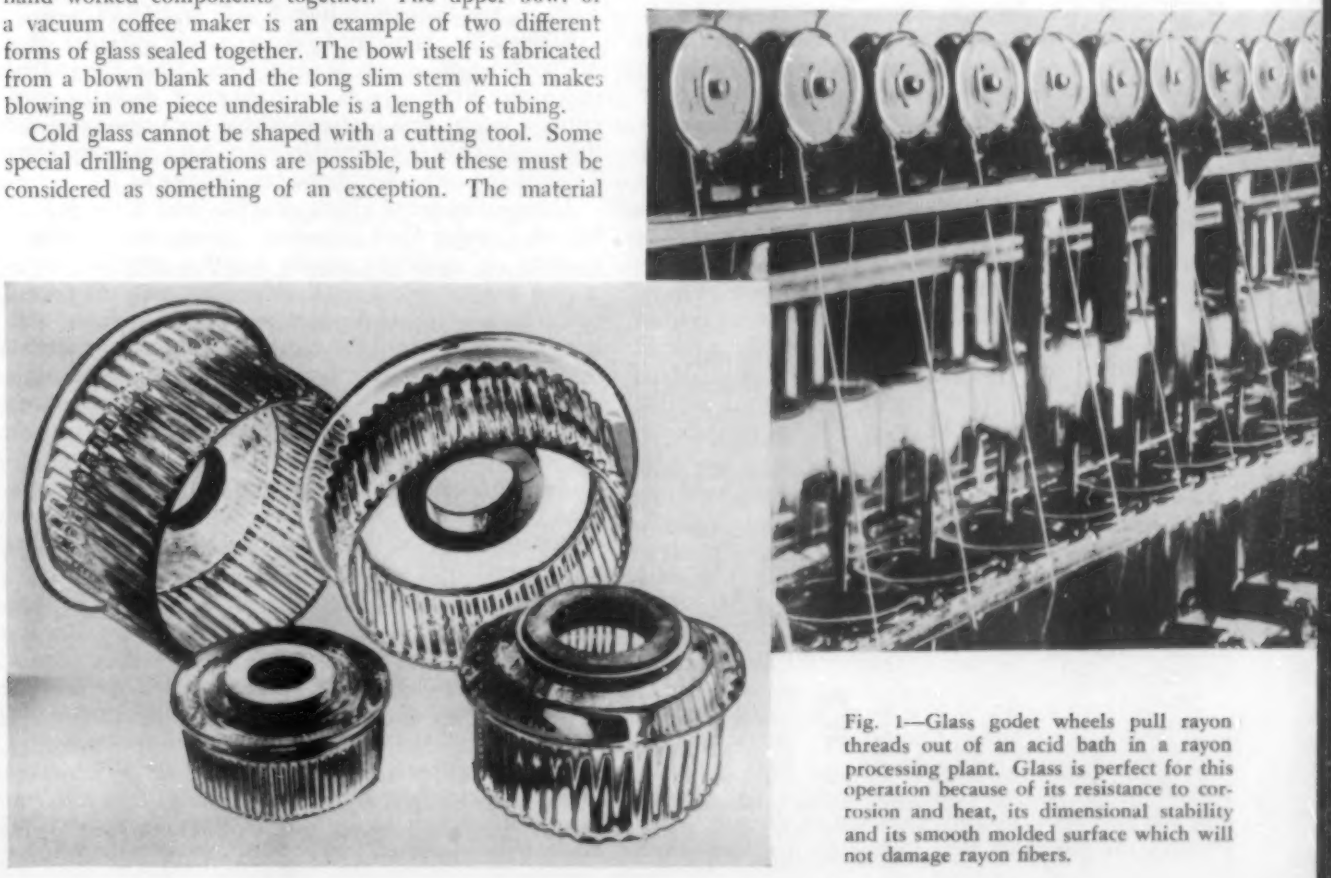


Fig. 1—Glass godet wheels pull rayon threads out of an acid bath in a rayon processing plant. Glass is perfect for this operation because of its resistance to corrosion and heat, its dimensional stability and its smooth molded surface which will not damage rayon fibers.

size of clamping bolts or screws should be reduced to a point where, if pulled up to normal tensions, the resulting forces will not break the glass. Spring members, with or without bolts, may often be used to advantage.

During the past decade a number of new and special types of glasses have been developed and are now being produced commercially. Moreover, a number of new processes using standard glasses have been perfected which permit new and sometimes unusual applications of this material.

Metallized Glass

Metallizing glass facilitates the manufacture of such items as instrument windows which can be easily soldered into metal frames; encapsulating tubes that can be readily sealed to make a vacuum tight enclosure for electronic components such as resistors and capacitors; and glass tubes metallized to form inductance coils with terminals to which leads can be soldered by conventional methods.

Metallizing can be done in a number of ways, but the following have proved to be the most practical for assembling glass with metal parts by soldering:

(a) Metals such as brass or aluminum can be sprayed on with a metal spray gun. Meter windows are thus coated with brass and soldered to a metal fitting making a moisture proof seal.

(b) Coatings of silver or other noble metals are fired on at high temperatures and prepared for soldering to metal fittings with a final coat of tin or tin-lead solder. Such joints are vacuum tight and readily fabricated by the user. Low melting temperature alloys, such as half and half tin and lead, silver lead, or bismuth solders are recommended.

These recommendations should be followed when metallized assemblies are being planned. The metal parts soldered to the glass should be of thin gauge material, preferably 0.015 to 0.20 in. thick with 0.031 in. as a maximum. They should be proportioned so that the differential expansion between the materials can be taken up by flexing of the metal part. The design should be such that stresses caused by soldered metal parts will be as nearly normal to the glass surface as practicable. When tangential stresses occur, particularly those caused by temperature changes, they should be minimized by reducing the area of contact between metal and glass and by keeping the soldered metal $\frac{1}{8}$ in. to $\frac{3}{8}$ in. within the metallized area. Metal rings, caps and diaphragms should be designed so that the assembly stresses in the glass will be compressive, rather than tensile.

Multiform

Multiform is a term which can be applied either to a process or to a glass made by that process. The process is similar to powder metallurgy and it permits forming glass into a number of shapes considered impossible to make by conventional methods.

The processes applicable to a number of glass compositions having widely different properties. The parent glass is ball-ground, mixed with a binder, and then either dry pressed or slip cast into the desired shape. At present, only the high-silica content glasses can be slip cast. After forming, the pieces are fired to fuse the particles into a homogeneous mass which is as impervious to fluids and as satisfactory for high vacuum applications as any other glass.

Most Multiform glassware is white and translucent—rather than transparent, however, it can be colored when desired. For a given glass composition, other properties remain essentially the same as those for ware made by conventional methods.

Parts made by this method include bars, cylinders, rings, plates, and other shapes which need not be symmetrical or regular. A part may be cast with any number of holes and these should be parallel to the press stroke as in any pressing operation. When holes tangent to the axis are required, they can sometimes be drilled in the piece after pressing, but before sintering. In this stage of the process the material may be machined by any conventional method.

The weight of parts made of Multiform can vary from 0.001 of a pound to 50 pounds. Without finishing, tolerances may be held to as close as ± 0.005 in. Parts which have been successfully produced by this method include large, heavy bubble plates for fractionating columns and tiny diode and transistor cases as small as a matchhead.

Other objects made of Multiform include perforated flat plates 1 in. thick and 18 in. diameter, pump sealing rings, cylindrical forms, and smallsealing beads.

Ribbon Glass

One of the most unusual forms of glass developed recently is a thin, flexible, continuous ribbon (Fig. 2). The ribbon, a single homogeneous piece of glass is available in 100 ft. and 1,600 ft. rolls in widths from 0.093 in. to 1,000 in. and thicknesses from 0.0013 in. to 0.0019 in.

Ribbon has been made from widely different glass compositions on an experimental basis. Since the greatest importance to date has been placed on its dielectric properties, a special glass composition has been developed and this is the only one available today on a quantity basis. Table II presents some of the basic properties.

The greatest use of ribbon glass has been in the production of Corning fixed capacitors. These electronic components are made by sealing together alternate layers of glass and foil into a single, monolithic unit. As a result of the high dielectric constant and the thinness and uniformity of the ribbon, the capacitors are generally smaller in size and weight than other capacitors giving comparable performance. They need no supporting case or impregnant, are moisture resistant, exceptionally stable, and capable of operation at high temperatures.

Corning Glass Works patents prohibit the use of ribbon glass by any other manufacturer for the production of capacitors. However, the material is available for any other possible use.

96 Per Cent Silica Glasses

The 96 per cent silica glasses have unique characteristics that recommend them for practical utilities beyond the range of any other commercially produced glasses.

The glass is composed of approximately 96 per cent silica, the remainder being mostly boric oxide. It was developed primarily for high temperature applications and can be heated to 900 C and plunged into ice water without

breaking. Parts made of it can be used at a continuous operating temperature of 900 C and intermittently at 1200 C. In a laboratory demonstration, molten brass was poured into a 96 per cent silica glass crucible resting on a block of ice without damage to the crucible.

This glass has very good transmittance at wave lengths higher than 365 millimicrons. It transmits short-wave length infrared regions of the spectrum up to 305 microns. A number of standard shapes such as tubing, rod, containers, trays, and flat glass are available. It can be fabricated into any of the four basic forms—drawn, pressed, blown, and sheet.

A number of products which require unusual properties have been successfully manufactured from 96 per cent silica glass such as sheaths for immersion heaters, thermocouple protecting tubes, furnace trays, induction furnace linings, and laboratory ware.

Electrically-Conducting Glass

Electrically-conducting, or E-C, glass is essentially a borosilicate glass with a fired-on film of metallic oxide which serves as a conductor of electricity. The radiating and electrical insulating qualities of glass are thus effectively combined with the conductivity of metal. The size and shape of the glass may be varied as required and the electrical resistance of the coating can be controlled for various voltages and powers.

The conducting film which averages 16-millionths of an inch thick is transparent and tinted a shade of blue. When not in operation, it is more chemically durable than the glass and may be washed with all ordinary cleansers. Harsh abrasives, however, may cause scratches. Under operating conditions, the film should be protected from hot reducing atmospheres and electrolytes.

In panel form, E-C glass is now being used in a variety of applications as an industrial radiant heating medium. The glass is mounted in a frame with insulation and connections and is ready for operation simply by connection to a source of power. In this manner, E-C panels are being used for yarn and lacquer drying, petroleum fuel dehydration, and as an even source of heat in chicken brooders.

The common range of electrical resistances of E-C panels is from 6 to 100 ohms on a 12x12 in. plate. Proportional resistances are obtained on plates of varying sizes and shapes. Specified powers or resistances are produced within 5 per cent. Allowable power input depends on element temperature and effectiveness of heat transfer. With normal installations in free air power inputs can be as high as 10 watts per sq. in. and up to 40 watts per sq. in. when water cooled.

The uncoated side of the E-C glass radiates approximately twice as much heat as the coated side, the film itself acting as a metallic reflector. With the addition of a metal reflector, as much as 80 per cent of the input energy is available in the form of heat radiation from the uncoated side. At 327 C. the element will emit over 75 percent of its heat energy at a wave length of more than 4 microns. At these wave lengths, most organic materials and ceramics, regardless of color or surface conditions, absorb a high percentage of heat radiated to them. Clean metals, however, are good reflectors of this radiation. The panels are highly resistant to thermal shock.

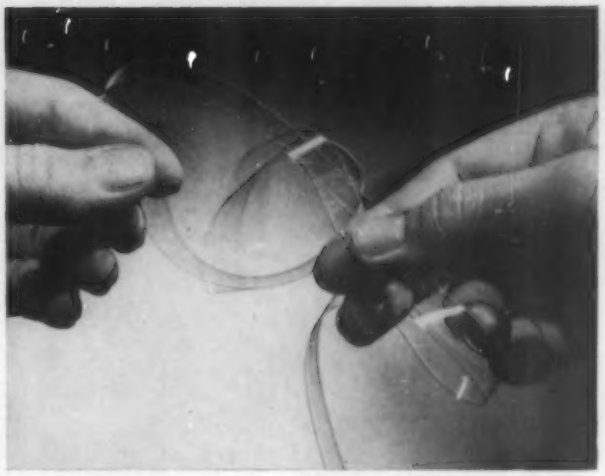


Fig. 2—This ribbon of glass, about 0.001 in. thick, can be rolled, twisted or wrapped around a small diameter. Its electrical properties are the equal of high-grade mica. It is used for fabricating electrical capacitors for television, radio and other electronic devices.

Table II—Properties of Ribon Glass

Thermal Expansion Coefficient 1 C	104×10^7
Viscosity Data:	
Strain point	357 C
Annealing Point	384 C
Softening Point	531 C
Density (Sp. gr.)	3.6
Dielectric Properties at 1 Mc and 20 C:	
Power Factor	0.00045
Dielectric Constant	8.45
Loss Factor	0.40

In the electronics industry, E-C glass is now being used in tube and rod form in the manufacture of resistors. The use of this type of glass in this manner is a highly specialized subject. It should be noted that it can be used in tubular form with the conductive coating laid on as a solid coat or a spiral path.

Photosensitive Glass

Photosensitive glasses are clear, high quality glasses which, subjected to a combination photographic and heat process, reproduce permanently in glass, a photographic image in any one of a number of shades.

The first major technical application of photosensitive glass is in lighting and is known as Fotolite. A gridwork of opal bars is placed photographically in a glass sheet through its entire thickness. The sheet can be then fitted into fixtures calling for glass panel shields to provide a soft, diffused, glareless light.

One photosensitive glass, called Fotoform, can be "chemically machined." The method consists of forming in the glass a three-dimensional photographic image which is a great deal more soluble in acid than the adjacent unexposed areas of the glass. This glass is used where there is a need for multiple holes, complex in shape and precise in spacing and dimensions, or for small and irregular shapes. For example, holes 0.010 in. holes have been made in a 0.50 in. thick plate with a tolerance of 0.0005 in.

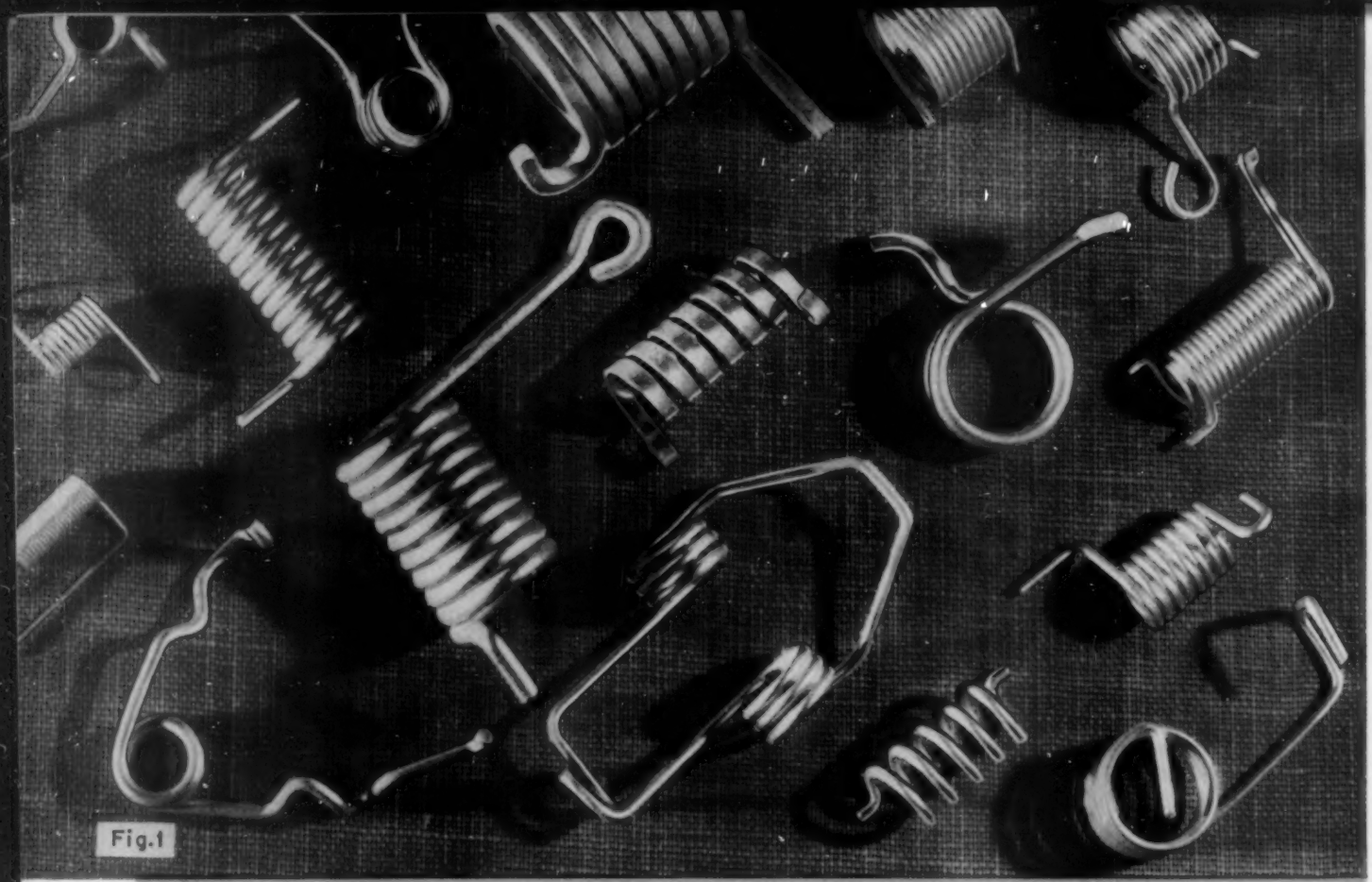
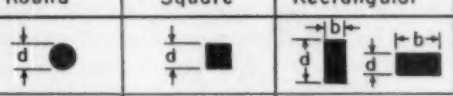


Fig. 1 (Above)—Assortment of torsion springs illustrates the range of sizes, shapes and arms that can be produced to meet specific requirements.

Fig. 2 (Opposite page)—When length of arms approaches length of wire in spring body, spring gradient including arm deflection must be adjusted to account for arm deflection.

Table I—Torsion Spring Gradients

Value	Cross-Section of Wire		
	Round	Square	Rectangular
			
K	$\frac{Ed^4}{1170L}$	$\frac{Ed^4}{688L}$	$\frac{Ebd^3}{688L}$
S_b	$\frac{10.2MR_2}{d^3}$	$\frac{6MR_4}{d^3}$	$\frac{6MR_4}{bd^2}$

Note: R_2 and R_4 are stress concentration factors, See Fig. 3

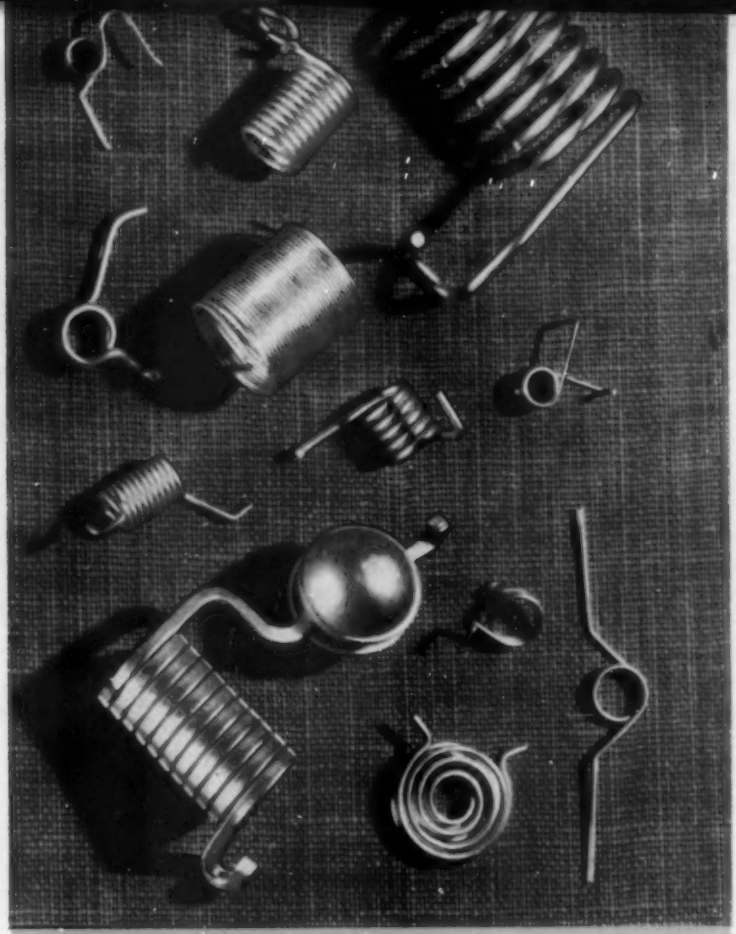
Torsion Spring Design

S. L. ALBRIGHT
Hunter Spring Company

ALTHOUGH NOT USED AS WIDELY as compression and extension types, torsion springs are useful in a wide range of sizes and shapes, as shown by the above illustration. Thus, their design—which is already long and complicated—can involve wide variations in materials, stresses, and moments as well as wire diameters, shapes and types of arms.

The design procedure shown on page 140 can simplify this problem for close-wound and open-wound springs. Special types such as minimum gradient, noncircular wire, inner-and-outer, and double torsion springs will be discussed separately.

An important feature of this procedure—in addition to organizing and simplifying computations—is that it includes a practical evaluation of life requirements, avoiding such vague criteria as "long" or "short" life. Other features as well as supporting data and suggestions for its use will be pointed out in the following discussion.



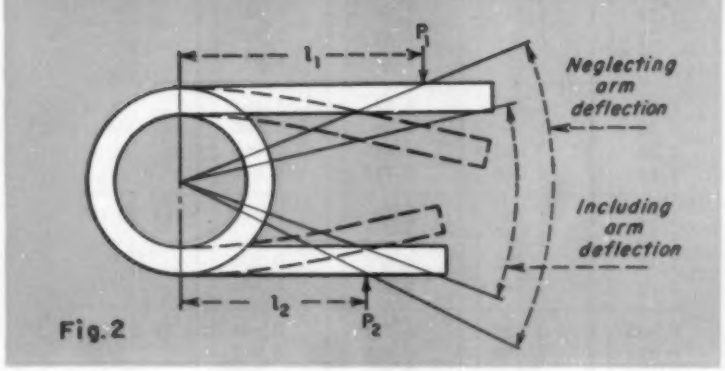
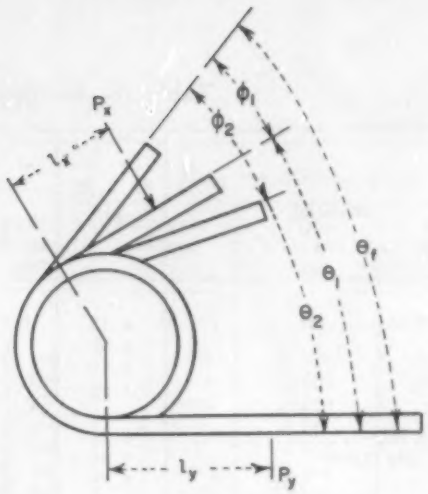


Fig. 2



SYMBOLS

A	correction factor for stress ratio and material
d	wire dia, (round wire), in.
D	mean dia in free position, in.
D'	mean dia of coil body in max working position, in.
D_S	shaft dia, in.
D_T	tentative mean dia in max working position, in.
E	Young's modulus, psi
h	body length in free position (close-wound), in.
h'	body length in max working position, in.
H	body length in free position (open wound) in.
ID	inside dia of coil in free position, in.
K	gradient, lb-in. per deg
l,	active length of torsion-spring arm, in.
L	active length of wire, including arms, in.
L_b	active length of wire in torsion-spring body, in.
M_1	initial moment, lb-in.
M_2	final moment, lb-in.
M_T	corrected moment, lb-in.
N	number of coils in free position
N_T	tentative number of coils in max working position
N'	number of coils in maximum working position (N_T adjusted so that fractional coil agrees with relative position of arms)
OD	outside dia of coil in free position, in.
R_2	Wahl stress concentration factor (round wire, bending)
R_4	Wahl stress concentration factor, (square wire, bending)
S	basic stress, psi
S_r	stress ratio
θ_1	initial angle between arms, deg
θ_2	final angle between arms, deg
θ_f	free angle between arms of torsion spring, deg
ϕ_1	initial angular deflection, deg
ϕ_2	final angular deflection, deg

This step-by-step procedure simplifies calculations, replaces trial-and-error techniques, quickly shows whether a standard type spring will meet requirements, and indicates whether a change in associated components is necessary.

I—Application Requirements

The spring forces or moments required for any given application can be determined by theoretical calculation, empirical estimation, trial-and-error techniques, or by direct measurement.

The spring gradient is given in the design procedure chart as

$$K = (M_2 - M_1) / \theta_2 - \theta_1$$

The equation for K, which in Table II on page 138 is expressed in terms of spring dimensions and E (Young's Modulus) is normally used when the deflection of spring arms can be disregarded. However, when the length of wire in the "active" arms approaches that in the spring coils, an appreciable error may be introduced. For example, in Fig. 2 note that the spring arms, deflecting as cantilever beam, increase the total deflection under a given loading.

In selecting a material, such factors as strength, endurance limit, cost, availability, corrosion resistance, stability

Table II—Correction Factor "A" for Torsion Springs

Material	$\frac{M_2 - M_1}{M_2}$	Cycles					
		5,000	10,000	50,000	100,000	Infinite	Young's Modulus E—psi
Music Wire	0.25	1.28	1.23	1.11	1.06	0.954	30×10^6
	0.50	1.23	1.16	1.00	0.926	0.762	
	0.75	1.21	1.12	0.928	0.845	0.652	
	1.00	1.17	1.08	0.864	0.771	0.551	
Stainless Steel Type 302 (18–8)	0.25	0.918	0.899	0.835	0.807	0.771	29×10^6
	0.50	0.885	0.845	0.758	0.720	0.634	
	0.75	0.853	0.803	0.685	0.634	0.514	
	1.00	0.826	0.761	0.615	0.552	0.413	
Oil Tempered Spring Steel	0.25	1.23	1.20	1.12	1.09	1.01	29×10^6
	0.50	1.18	1.13	1.00	0.945	0.819	
	0.75	1.14	1.07	0.896	0.821	0.650	
	1.00	1.10	1.01	0.800	0.710	0.500	
Oil Tempered Chrome Vanadium and Hard Drawn Steel	0.25	1.05	1.02	0.955	0.927	0.859	29×10^6
	0.50	0.991	0.941	0.826	0.776	0.660	
	0.75	0.962	0.896	0.746	0.681	0.529	
	1.00	0.941	0.865	0.694	0.620	0.450	
Oil Tempered Chrome Silicon	0.25	1.35	1.32	1.24	1.20	1.11	29×10^6
	0.50	1.30	1.24	1.10	1.04	0.901	
	0.75	1.25	1.18	0.985	0.903	0.715	
	1.00	1.21	1.11	0.880	0.781	0.550	
Beryllium Copper	0.25	1.91	1.87	1.78	1.75	1.67	18.5×10^6
	0.50	1.84	1.78	1.64	1.58	1.42	
	0.75	1.78	1.71	1.51	1.42	1.22	
	1.00	1.75	1.62	1.38	1.27	1.00	
Monel	0.25	1.49	1.44	1.32	1.27	1.16	
	0.50	1.41	1.33	1.14	1.06	0.866	26×10^6
	0.75	1.36	1.24	0.995	0.889	0.644	
	1.00	1.31	1.19	0.901	0.777	0.511	
Phosphor Bronze	0.25	1.33	1.29	1.16	1.10	0.979	14.5×10^6
	0.50	1.27	1.18	1.00	0.923	0.734	
	0.75	1.22	1.13	0.899	0.800	0.578	
	1.00	1.19	1.09	0.825	0.711	0.445	
Brass	0.25	0.822	0.800	0.738	0.711	0.644	14.5×10^6
	0.50	0.795	0.751	0.658	0.618	0.511	
	0.75	0.769	0.722	0.591	0.534	0.420	
	1.00	0.738	0.689	0.542	0.478	0.334	

at elevated temperatures and magnetic properties should be considered.

Accompanying Table II and III include data on commonly used metals: music wire, stainless, carbon steel, copper and nickel alloys.

II—Basic Spring Calculation

Having established the final moment, M_2, which is required when the spring is deflected, a correction factor A must be applied to account for material, life expectancy, and the load range. Values for this factor are given in Table II.

With the corrected value of moment, $M_t = M_2/A$, a wire diameter is chosen from Table III corresponding to a tabular moment equal to or slightly greater than M_T. The next step in the chart, Step 5, calls for a shaft diameter D_s. This applies when the spring must operate with a shaft or similar member positioned within the coils. If there is a free choice of shaft diameter, a value of nine times the wire diameter or slightly larger is recommended. If the spring will not have an internal member, this step should be omitted.

In establishing a tentative value for the mean diameter of the spring, Step 6, a clearance of about 10 per cent (represented by the factor 1.1) is usually safe and allows for minor adjustments which may follow.

If there is no internal shaft, then a D_t of about 10 times the wire diameter is an optimum suggested value. When the ratio D_t/d must be less than 10, a stress concentration factor must be included, Fig. 3, and a new

Table III—Corrected Moment Chart

Music Wire and Stainless			Carbon and Alloy Steels			Copper and Nickel Alloys		
Corrected Torque lb-in	Wire Diameter in.	Basic Stress psi	Corrected Torque lb-in.	Wire Diameter in.	Basic Stress psi	Corrected Torque lb-in.	Wire Diameter in.	Basic Stress psi
M_t	d	S	M_t	d	S	M_t	d	S
0.0101	0.008	201,000	1.013	0.041	149,500	0.00358	0.008	71,200
0.0143	0 009	200,000	1.555	0.0475	148,000	0.00509	0.009	71,000
0.0196	0.010	199,500	2.27	0.054	146,700	0.00694	0.010	70,800
0.0259	0.011	198,500	3.47	0.0625	145,000	0.00925	0.011	70,600
0.0337	0.012	198,000	5.24	0.072	143,000	0.0152	0.013	70,500
0.0425	0.013	196,800	7.12	0.080	141,500	0.0189	0.014	70,200
0.0527	0.014	195,500	10.49	0.0915	139,800	0.0281	0.016	69,800
0.0780	0.016	194,000	11.21	0.0937	139,000	0.0398	0.018	69,500
0.1103	0.018	193,000	15.72	0.1055	136,600	0.0546	0.020	69,300
0.1505	0.020	192,000	23.05	0.1205	134,000	0.0827	0.023	69,100
0.199	0.022	190,000	25.5	0.125	133,000	0.1056	0.025	69,000
0.256	0.024	189,000	31.8	0.135	131,700	0.1635	0.029	68,200
0.323	0.026	187,500	41.4	0.1483	129,200	0.219	0.032	67,900
0.443	0.029	185,000	48.0	0.1562	128,100	0.310	0.036	67,700
0.533	0.031	182,000	53.1	0.162	127,100	0.422	0.040	67,200
0.638	0.033	181,000	68.0	0.177	124,800	0.598	0.045	66,900
0.755	0.035	179,500	79.8	0.1875	123,100	0.866	0.051	66,500
0.886	0.037	178,000	85.0	0.192	122,400	1.194	0.057	65,600
1.030	0.039	177,000	104.6	0.207	120,200	1.664	0.064	64,600
1.185	0.041	175,500	116.5	0.2187	118,400	2.35	0.072	64,100
1.350	0.043	173,000	131.0	0.2253	117,000	3.17	0.080	63,200
1.535	0.045	171,500	163	0.2437	115,000	4.61	0.091	62,300
1.73	0.047	170,000	175	0.250	114,000	6.48	0.102	61,600
1.95	0.049	169,000	199	0.2625	112,200	8.82	0.114	60,600
2.18	0.051	167,500	239	0.2812	109,600	11.5	0.125	59,800
2.70	0.055	165,000	301	0.3065	106,400	12.2	0.128	59,500
3.26	0.059	162,000	315	0.3125	105,300	17.2	0.144	58.500
3.95	0.063	161,000	367	0.331	103,000	23.9	0.162	57,200
4.70	0.067	159,300	405	0.3437	101,700	33.4	0.182	56,200
5.50	0.071	157,000	464	0.3625	99,000	45.9	0.204	55,100
6.39	0.075	154,000	506	0.375	97,800	63.5	0.229	53,800
7.68	0.080	153,000	575	0.3938	95,800	88.7	0.258	52,600
9.04	0.085	150,000	623	0.4062	94,600	122	0.289	51,300
10.56	0.090	147,500	753	0.4375	91,800	169	0.325	50,100
12.30	0.095	146,500	898	0.4687	88,800	234	0.365	48,800
14.35	0.100	146,000	1060	0.500	86,500	320	0.410	47,300
16.98	0.106	145,000	1445	0.5625	82,700	441	0.460	46,200
19.80	0.112	143,600	1910	0.625	79,800			
23.0	0.118	142,000						
27.0	0.125	141,000						

value of M_t calculated using the formula given in the "check point."

In determining the number of turns, Steps 10–12, slight adjustments in shaft diameter or clearance may be necessary. All dimensions refer to the spring in its fully-loaded working position. The simplest and most direct way to adjust clearance is to add or subtract one or more full turns.

Steps 13–15 establish the size of the spring in its free position to determine whether or not some external limiting dimension will be satisfied. When space economy is a factor, close-wound springs are used. Open-wound torsion springs are sometimes desirable, either to reduce inter-coil friction or to fill available axial length. Under the latter condition, it is advisable to consider

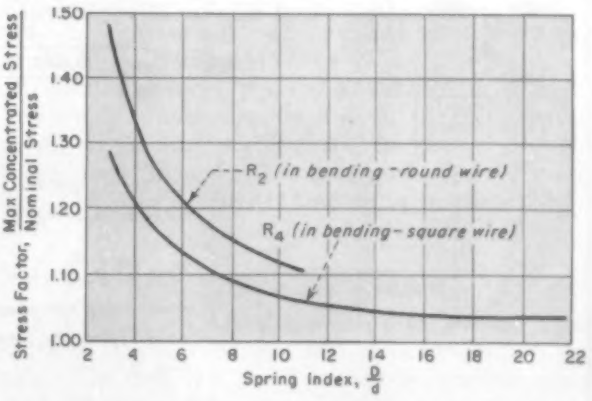


Fig. 3—Wahl stress concentration factor, above, must be included in calculating corrected moment when D/d is less than 10, or when non-circular wire is used.

Design Procedure for Torsion Springs

I APPLICATION REQUIREMENTS

1. Initial moment, M_1 ---------- **1.30 lb-in.**
2. Final moment, M_2 ---------- **1.72 lb-in.**
3. Gradient, $K = \frac{M_2 - M_1}{\phi_2 - \phi_1}$ -------- **0.01135 lb-in. per deg**
4. Material ---------- **Music Wire**
5. Number of cycles ---------- **100,000**

II BASIC SPRING CALCULATION

1. Stress ratio, $S_r = \frac{M_2 - M_1}{M_2}$ ------ **0.244**
2. Correction factor, A, Table II --- **1.06**
3. Corrected moment, $M_T = \frac{M_2}{A}$ --- **1.62 lb-in.**
4. Tabulated values from Table III
   - (a) Moment, M_T ---------- **1.73 lb-in.**
   - (b) Wire dia., d ---------- **0.047 in.**
   - (c) Basic stress, S ---------- **170,000 psi**
   - (d) Young's modulus, E -------- **30 x 10^6**
5. Dia. of shaft (or other limiting internal member), D_S ---------- **0.437 in.**
6. Tentative mean dia. at maximum working position

   $D_T = 1.1(d - D_S)$ ---- **0.532 in.**

   CHECK POINT

   $\frac{D_T}{d} = (11.3)$ in which $\frac{D_T}{d}$ must be ≥ 10

   If $\frac{D_T}{d} < 10$, repeat steps 3-4, using $M_f = \frac{M_2}{A}\left(\frac{R_2}{1.13}\right)$ and eliminating this check point. (For R_2, see Fig. 3)

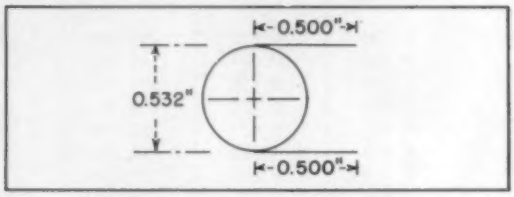
   If D_S is not specified, assume $D_T = 10d$

7. Active length of wire including arms

   $L = \frac{d^4 E}{1{,}170\,K}$ ---------- **11.00**

   (For springs with many coils and short arms)

8. Simple line sketch of spring in maximum working position (fully-loaded), showing D_T, (from step 6) to determine length of arms. *Spring should be designed to be loaded in direction of original winding.*



9. Active length of wire in body

   $L_b = L - \left(\frac{l_1}{3} + \frac{l_2}{3}\right)$ -------- **10.67 in.**

10. Tentative number of coils in maximum working position $N_T = \frac{L_b}{\pi D_T}$ ----- **6.36**
11. Number of coils N' with partial coil adjusted to agree with desired position of arms in sketch ------- **6.5**

    CHECK POINT

    Body length $h' = d\,(N' + 1)$ -- **0.352 in.**

    If maximum available space for the body length is specified, it must exceed h'

12. Mean diameter of coiled body in maximum working position $D' = D_T\left(\frac{N_T}{N}\right)$ --- **0.521 in.**

    CHECK POINT

    ID in maximum working position, $D' - d$ ---- **0.474 in.**

    $D' - d$ must be $> D_S$

13. Required angular deflection, $\phi_2' = \frac{M_2}{K}$ **151.5 deg.**

14. Number of turns in free position,
$N = N' - \frac{\phi_2}{360}$ ---------- 6.089

15. Mean dia. in free position,
$D = D'\left(\frac{N'}{N}\right)$ ---------- 0.556 in.

16. Body length (for close-wound spring), in free position, $h = d\,(N + 1)$ --- 0.333 in.

CHECK POINT *If minimum body length is specified it must be smaller than h.*

III. VARIATIONS AND LIMITS

1. Coil dia.

Mfg. variation, ΔD (Fig. 4) ------ 0.009 in.

Tolerance $2\Delta D$ ---------- 0.018 in.

CHECK POINT Free outside dia
$OD = (D + d)$ ------ 0.603 in.
If a maximum available space for the body diameter is specified, it must exceed OD.

2. Body length variation ΔH for open-wound torsion spring of specified length H (see Fig. 5) ---------- 0.023 in.

3. Free angle variation $\Delta\theta f$ (see Fig. 6) 18 deg

4. Gradient variation $\frac{\Delta K}{K} = \sqrt{X}$ (see Fig. 7) ---------- 2.23 per cent

5. Initial moment variation
$\Delta M_1 = \frac{M_1}{100}\sqrt{X + \left(\frac{\Delta\theta f}{\phi_1} \times 100\right)^2}$ 0.206 lb-in.

6. Final moment variation
$\Delta M_2 = \frac{M_2}{100}\sqrt{X + \left(\frac{\Delta\theta f}{\phi_2} \times 100\right)^2}$ 0.208 lb-in.

(Numbers in boxes represent numerical example)

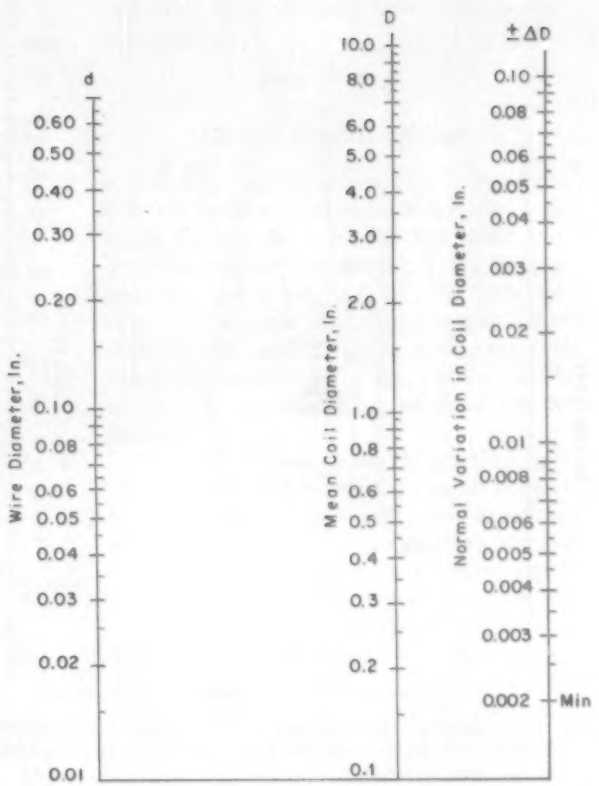


Fig. 4—Nomograph for determining manufacturing tolerances on coil diameter based on what is good practice today.

increasing length by means of a smaller coil diameter rather than by using an open pitch so great as to permit parts to become tangled or to increase handling costs.

III—Variations and Limits

Variations in body length ΔH, free angle $\Delta\theta_f$, initial moment ΔM_1, and final moment ΔM_2 can be determined by using the nomograms in Figs. 4, 5, 6 and Table IV. These give the limits of economical manufacture. Stricter specifications can be met, but should be justified in view of the higher costs involved.

As a practical possibility, D can be held to a specified tolerance of $\pm\Delta D$ when required, but this does not then permit specifying ΔM_1 when ΔM_2 or $\Delta\theta_f$ is also specified or, ΔM_2 when ΔM_1 or $\Delta\theta_f$ is also specified or $\Delta\theta_f$ when ΔM_1 or ΔM_2 is also specified.

Normally, an overall tolerance of $\pm 2\Delta D$, Fig. 4, should be allowed in specifying the OD of torsion springs to permit the manufacturer to obtain the gradient necessary to hold both moment and free angle tolerances by adjusting OD to compensate for variation in commercial tolerances.

Minimum Gradient Springs

In many applications, it is desirable to have the initial and final moments (M_1 and M_2) as nearly equal as possible. This requires a "soft" or minimum gradient spring. This is achieved by using a maximum length of wire in the spring body. Since $L_b = \pi DN$, body length of

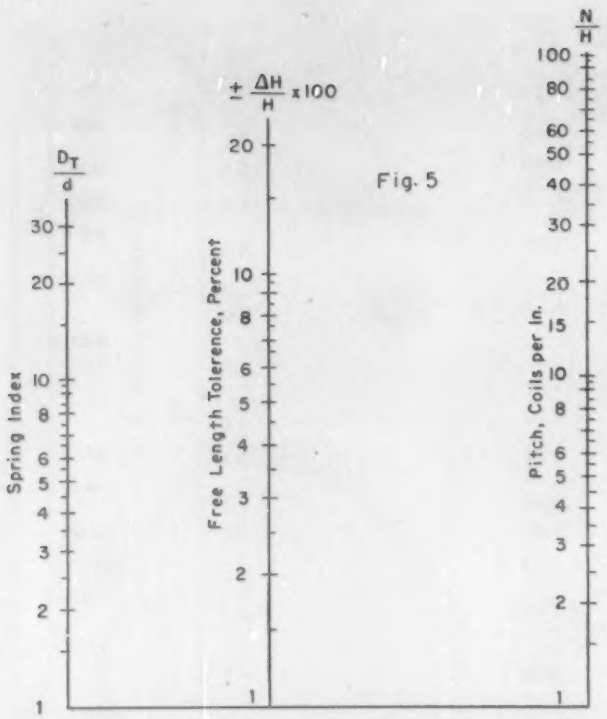


Fig. 5—Nomograph for determining the variation in body length in open-wound torsion springs based on currently available equipment and methods.

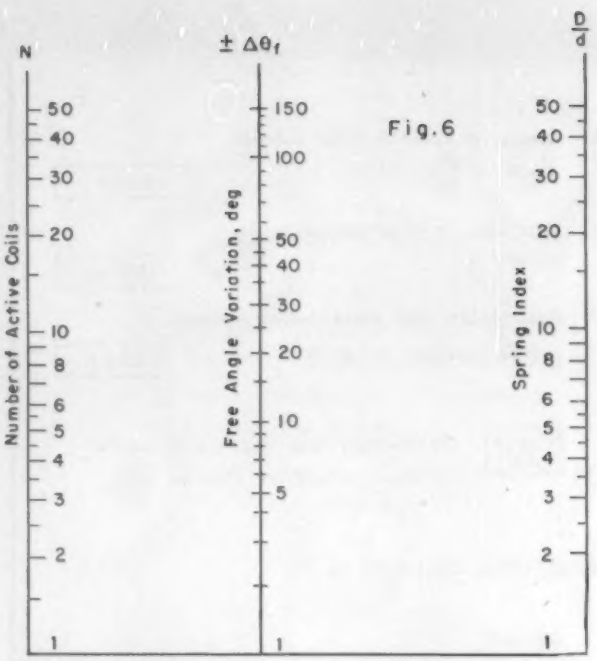


Fig. 6—Nomograph for free-angle variation. In manufacturing a torsion spring, a wire is wound on a mandrel of selected size. When this wire is released from the tight-wound position, the diameters of the coils increase slightly due to what is known as "spring back" of the wire. Since it can be assumed that the length of the wire will always be the same, spring back variation will result in a variation in the relative position of the two torsion spring arms. This variation in the position of the arms is termed "free angle variation" ($\Delta\theta_f$).

The nomograph, above, can be used to determine standard free angle variation, which can then be used to predict the torque variation at the deflected position. This nomograph resulted from a research program which involved a study of commercial spring wire variation and production capabilities and covers the average case. To use, merely draw a straight line from the number of active coils (*N* line) to the numerical value of the spring index (D/d) and read the free angle variation, in degrees, on the line $\Delta\theta_f$.

wire is maximum when mean coil diameter D and number of active coils N are as large as possible in the space available.

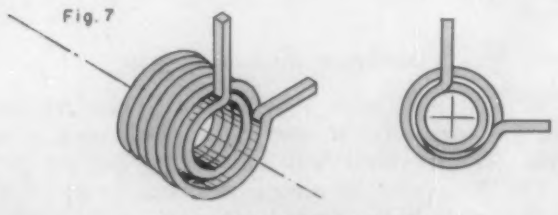
Square and Rectangular Wire

Square and rectangular wire are often specified where either outside diameter or body length h or both are too large for the volume available for the spring. The procedure for designing with square or rectangular wire is similar to that given for round wire. The only differences are in calculation of the gradient and stress, Table II and Fig. 4.

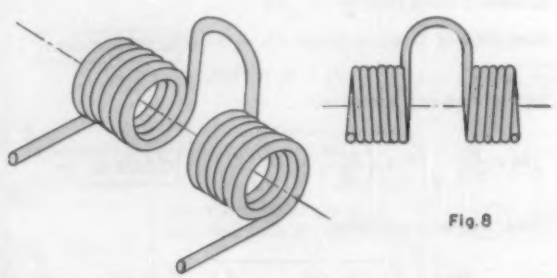
Inner-and-Outer Torsion Springs

An inner-and-outer torsion spring, Fig. 7, is wound continuously in two body sections of different diameters, one within the other. Because the gradients of the body sections are in series, lower resultant spring gradient and greater deflections are obtained than for single-body springs requiring the same space. Depending on the particular design, gradients may be reduced nearly 50 per cent and deflections almost doubled.

An inner-and-outer torsion spring should be used only when (1) space limitations on D and N do not allow the designer to obtain sufficient body length of wire L_b or (2) the application requires that both torsion-spring arms be in, or nearly in, the same plane. The inner body must have at least one more coil than the outer body. For manufacturing purposes, it is recommended that these



Inner and Outer Torsion Spring



Double Torsion Spring

Table IV—Factor "X" for Calculating △K and △M.

Wire Dia. *d*	*X*			Wire Dia. *d*	*X*		
	Music Wire and Stainless	Carbon and Alloy Steels	Copper and Nickel Alloys		Music Wire and Stainless	Carbon and Alloy Steels	Copper and Nickel Alloys
0.008	48		20	0.112	1.7		
0.009	42		19	0.114			8
0.010	36		19	0.118	1.6		
0.011	32		18	0.120		5	
0.012	28			0.125	1.5	4	8
0.013	26		17	0.128			8
0.014	24		16	0.130	1.4		
0.016	20		16	0.135		4	
0.018	17		15	0.138	1.3		
0.020	15		15	0.144			7
0.022	13			0.146	1.2		
0.023			14	0.148		3.3	
0.024	12			0.154	1.1		
0.025			13	0.156		3.2	
0.026	11			0.162	1.1	3.0	7
0.029	9		13	0.170	1.0		
0.031	9			0.177		2.7	
0.032			12	0.180	0.9		
0.033	8			0.182			7
0.035	7			0.187	0.9	2.5	
0.036			12	0.192		2.5	
0.037	7			0.204			6
0.039	6			0.207	0.8	2.3	
0.040			11	0.218		2.1	
0.041	6	16		0.225		2.0	
0.043	6			0.229			6
0.045	5		11	0.244		1.8	
0.047	5	13		0.250		1.8	
0.049	5			0.258			6
0.051	5		10	0.262		1.7	
0.054		11		0.281		1.6	
0.055	4			0.289			6
0.057			10	0.306		1.4	
0.059	4			0.312		1.4	
0.063	3.5	9		0.325			5
0.064			10	0.331		1.3	
0.067	3.3			0.344		1.2	
0.071	3.0			0.362		1.2	
0.072		8	9	0.365			5
0.075	2.8			0.375		1.1	
0.080	2.6	7	9	0.394		1.0	
0.085	2.4			0.406		1.0	
0.090	2.2			0.410			5
0.091		6	8	0.437		0.9	
0.093		6		0.460			5
0.095	2.1			0.468		0.8	
0.100	2.0			0.500		0.8	
0.102			8	0.562		0.7	
0.106	1.8	5.0		0.625		0.6	

springs be made from square instead of conventional round wire. To permit greater flexibility in manufacture to meet specifications do not specify the mean coil diameters of the two body sections but give only the maximum allowable spring outside diameter when free and the minimum allowable inside diameter when the spring is wound-up.

Double Torsion Springs

A double torsion spring, Fig. 8, is wound with two body sections of equal diameter (and equal number of coils) on the same axis. Torque is exerted between the spring ends, as one unit, and a loop between the body sections. For a given wire diameter and a coil diameter, the double torsion spring has four times the gradient of a single-body torsion spring with the same total length of wire in the body.

A double torsion spring is practical only when the two body sections are equal in every way except in orientation of arms. Since the gradient is the sum of the gradient of each section, each body section has a gradient equal to one-half of the specified gradient.

Because they usually cost considerably more than conventional single-body types, these springs should be used only when the balanced loading between the two arms and center loop (no external restraint) is required.

EARLIER ARTICLES IN THIS SERIES

Because the design of springs tends to be both complex and time consuming, the editors of *Product Engineering* have made a concerted effort to uncover simplified design procedures that will be satisfactory for most applications. In March 1951, page 136, appeared "Simplifying Helical Spring Design," by Carl Thumim and H. A. Riester. This included a step-by-step procedure for designing compression and extension springs for minimum cost by taking into account manufacturing tolerances. In May 1953, page 154, was "A New Approach to Compression Spring Design," by K. W. Maier, in which a simple graphical solution was developed by introducing a new spring parameter called the precompression factor. This was defined as initial deflection divided by stroke. Finally, in January 1949, page 161, began Part I of six installments by Leslie W. Jones, "Belleville Spring Design."

These three articles have been supplemented from time to time with data on physical properties, design specification, tolerances, dynamic performance characteristics, etc. For example, the following have appeared within the past 18 months:

"Dynamic Loading of Compression Springs," March 1955, page 162;

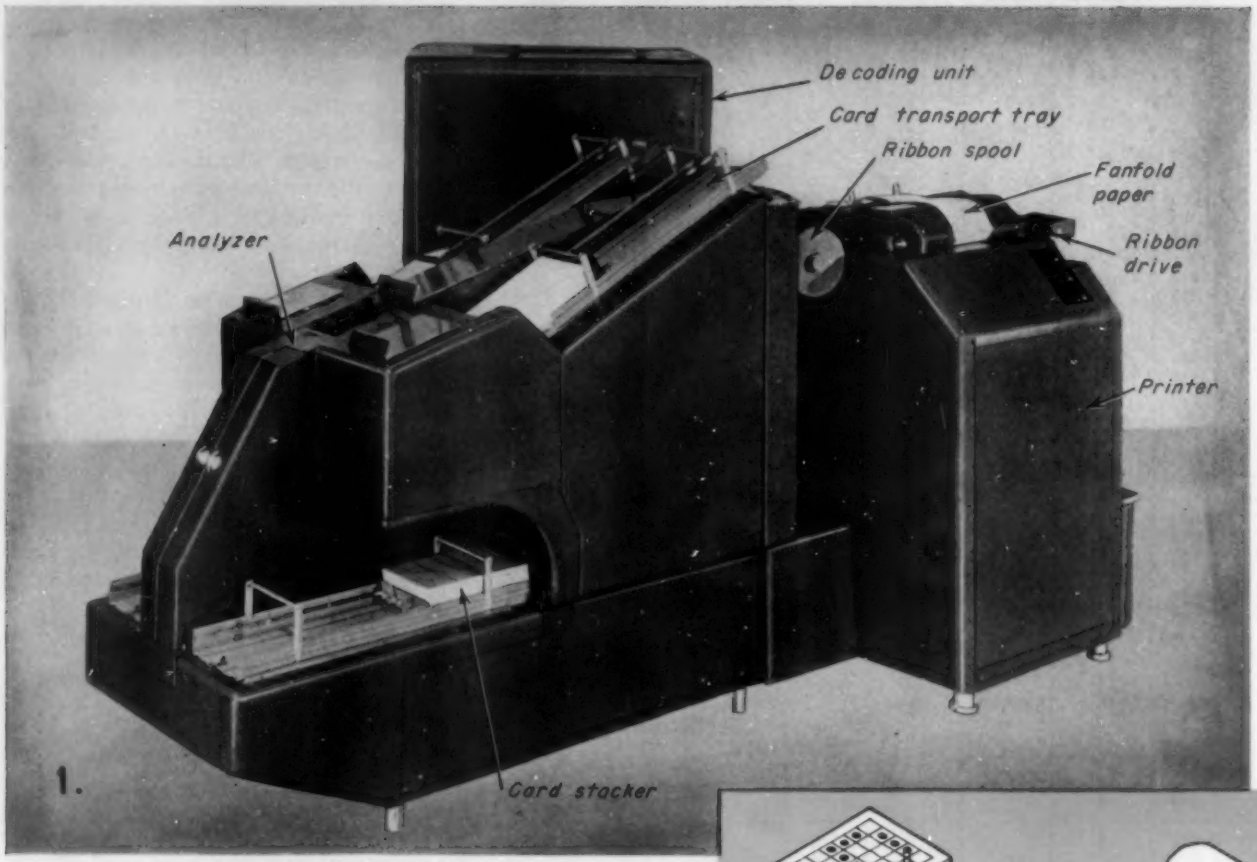
"Proportioning Helical Springs for Minimum Weight," November 1954, page 193;

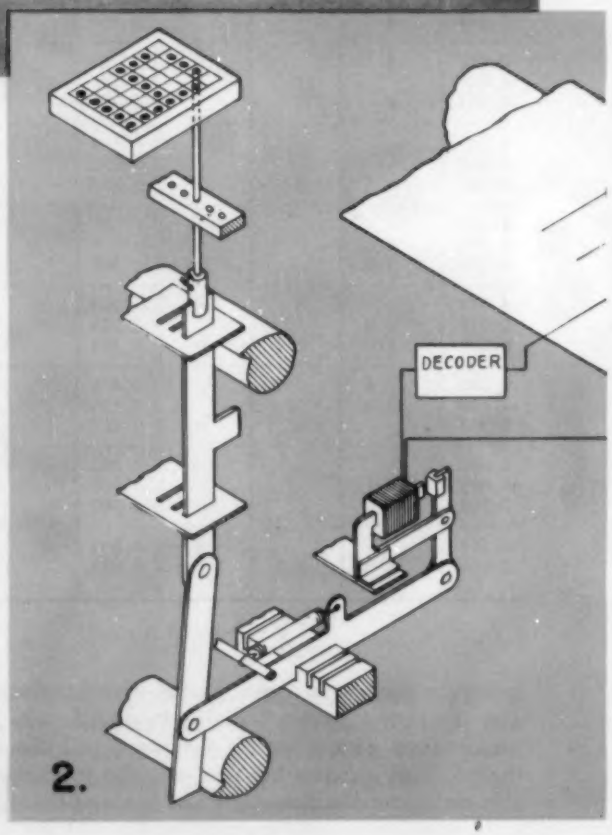
"Spring Design Data," (endurance values for compression springs and properties of spring materials), March 1954, page 217;

"Constant Force Compression Springs," September 1954, page 129; and

"Dynamic Loading of Compression Springs," January 1954, page 162.

DESIGN FEATURES

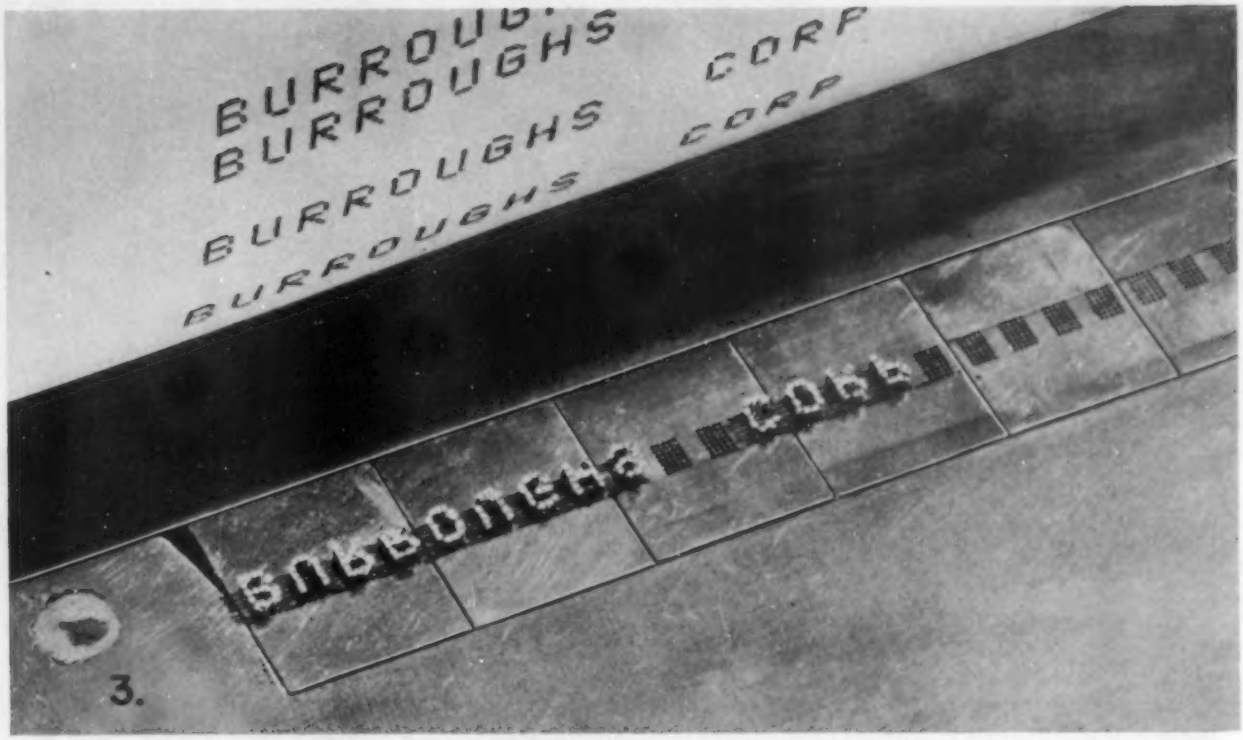


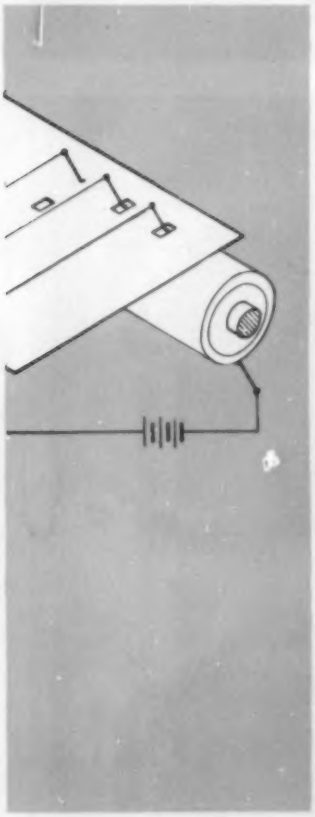


Punched-Card Fed High-Speed Printer

A high-speed tabulating and accounting machine with the fastest printing process yet produced for accounting purposes has been released by the Burroughs Corp., manufacturers of business equipment (adding machines to electronic computing systems). Developed by the Control Instrument Co., a Brooklyn, N. Y. subsidiary, the Series G machine prints 900 lines per min. Picker mechanism speed has been increased by separating picker knives from feed rolls, and an electronic decoder transmits punched card information to wire matrix print heads. The machine is designed specifically for business operations involving large quantity production where high speed results in lower processing cost.

IN NEW PRODUCTS





1. The three-component machine – analyzer, decoder and printer. Initial requirements were: 1) standard tabulating card input; 2) continuous paper form output; 3) double card feed; 4) minimum down-time; 5) production rate to justify any increased manufacturing costs. All requirements were fulfilled. The double card feed makes possible preparation of a merged printing record, eliminating the manual steps of combining and re-sorting separate card decks. The decoder can transmit to three outputs and provides data storage.

2. Printing is accomplished through wire generation of dot patterns. Individual wire is positively driven—to print portion of character and for return to original position. As input card is fed through analyzer, sensing brushes detect card punchings. Pulse is relayed through decoder to appropriate electromagnet in printer actuating assembly. Magnetic action permits mechanical linkage to force up print wire.

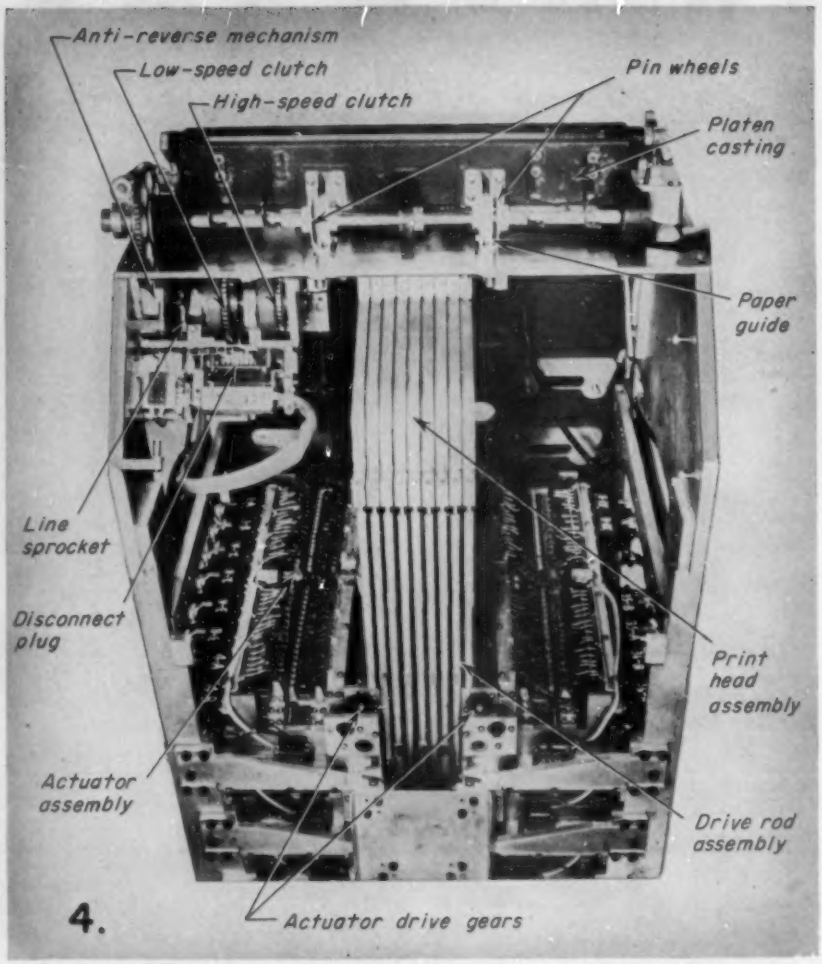
3. Shown larger than actual size, printed characters are only 0.100 in. high and 0.070 in. wide; wires are shown half-way through printing cycle. For clarity, wire ends are whitened and over-extended above matrices; platen and paper have been raised and ribbon removed. Wires are 0.011 in. music wire, cold-drawn to a tensile strength of 300,000 psi. Each matrix has 35 wires in a 7 x 5 rectangular array; 48 characters are assigned to the line, spaced eight characters per in. Six lines are printed per in., all characters printing simultaneously.

To print, wires move up about 0.025 in.; short distance and small wire mass makes possible high speed operation. Wires transfer dot patterns on paper by means of a one-time carbon ribbon; paper and ribbon are fed between matrix surface and flat platen. Print impact is effectively transmitted through multiple-copy paper forms. The wire diameter provides concentrated pressure on small contact area; just before wire impact the hardened steel platen moves to drive against back of paper form. Conventional models use a fixed, rubber platen. As platen is retracted during spacing, paper drag is reduced.

The platen is driven by a continuously rotating camshaft governed by solenoid-controlled interposers. Thirty-five square-faced stainless steel tubes contain wires to form matrix. Earlier consideration of drilling matrix failed to provide the consistent spacing accuracy required. Four matrices are hand-assembled in a print head ½ in. wide; the number of print heads used depends on the customer's needs. Paper print ribbon was selected after trying more expensive silk and plastic ribbons which deteriorated rapidly on repeated use. *(continued on next page)*

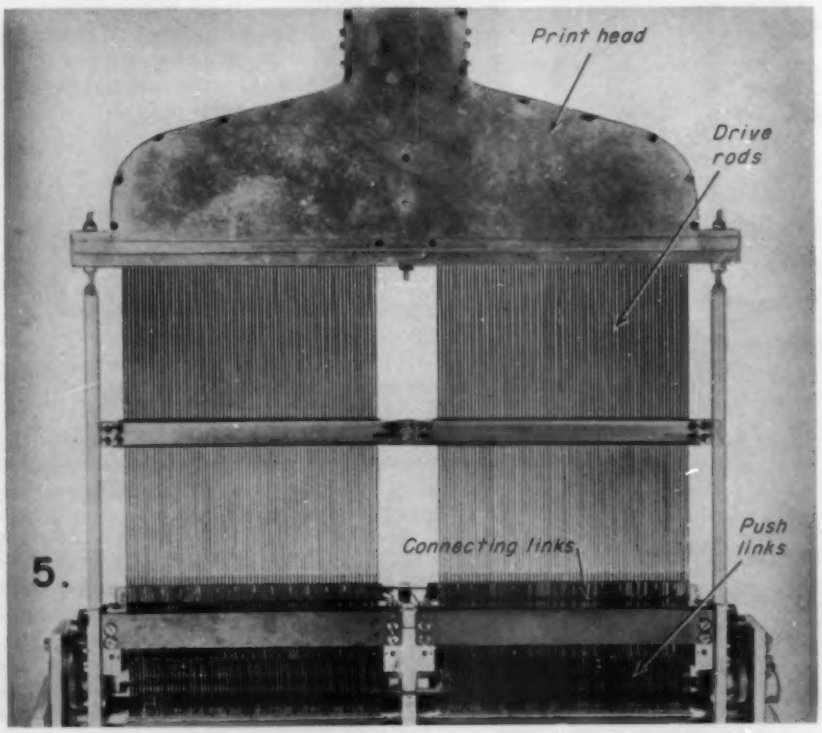
High-Speed Printer

(continued)

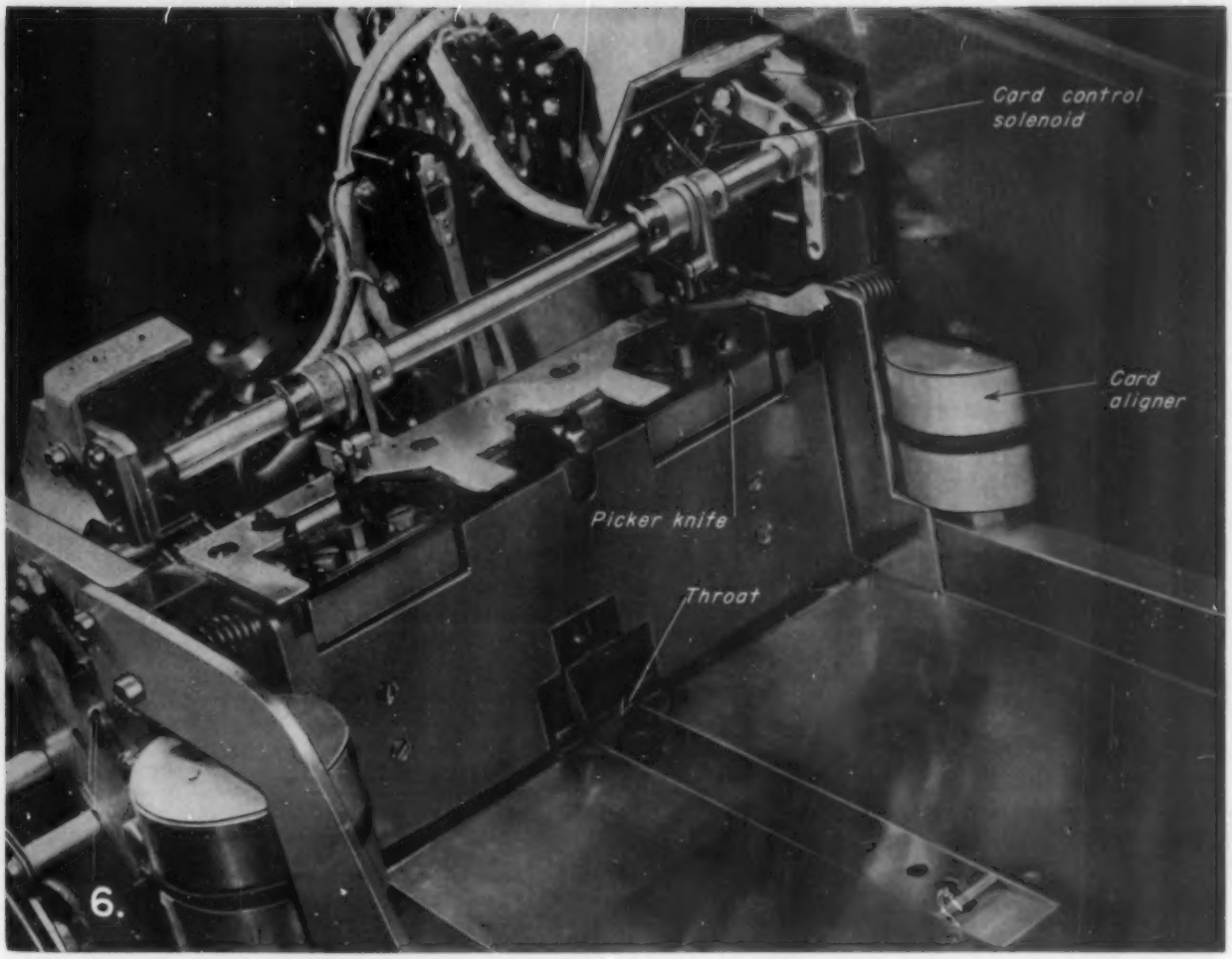


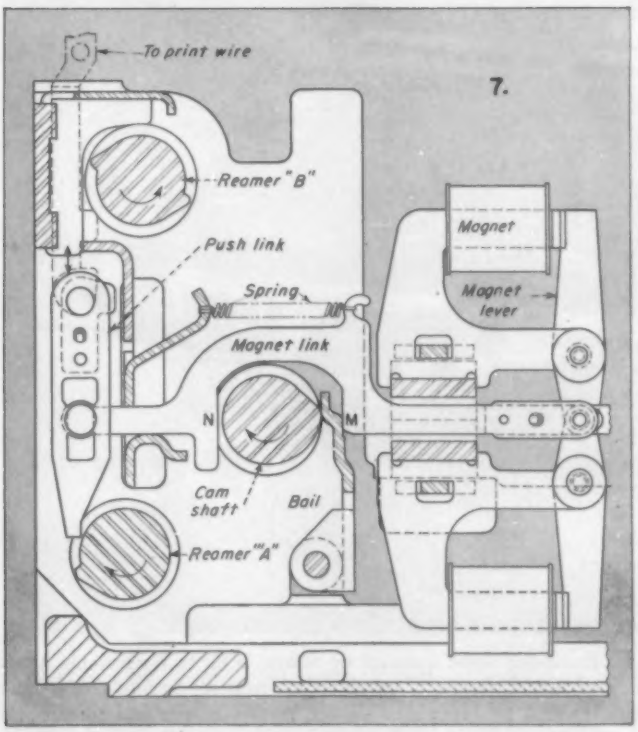
4. Front view of printer interior. Unit shown has nine print heads which feed total of 36 characters. Fully parallel in operation, 35 interposer magnets control print wires in each character. Actuator assembly consists of magnets, reamer and cam shaft, springs and linkages. Paper is pin-wheel driven. A retractable pin mechanism permits deeper grip for multiple-copy forms. Pins stay flush with wheel surface until paper rolls onto wheel, then project up through hole. Eccentric pin path is determined by cam non-concentric to center-line of pinwheel; fixed pins tended to deform holes. Paper spacing up to triple line is effected through a low-speed clutch; for longer spacing, a high speed clutch is engaged. Only one cycle or 1/900 sec is lost spacing from four to 16 lines. A free-wheeling disc is locked by spring-connected rollers, to prevent rebound of paper-feed drive. Wheels and bars are used in conventional units to select characters.

Masses and path lengths involved limit the maximum obtainable speed. Thus, from the start, emphasis was put on electrical components. A relay-spring mechanism was tried as was a permanent magnet arrangement, to actuate the wire. Both were rejected because of size factor; 1680 individual actuators are required. Thus, use was made of the ¼-watt electromagnet, capable of holding a link but too small to attract. Easy access to assemblies and drives is furnished; printing head may be quickly removed and replacement inserted. Relatively small number of mechanical components also helps reduce down-time.



5. One of the nine print head and drive rod assemblies shown in the view above. Print wires fan out into planar, harp-like array at right angles to the print line. Assembly houses 140 wires and pin-connected linkages. Aluminum-encased print head houses wire tubes embedded in hard wax. Gears shown at bottom drive reamers and camshaft.





6. Front view of card feed. In conventional units, picker knife and feed roll are connected and clutch-controlled, and the combined inertia limits picker speed to about 240 cards per min. But in this design, knives are separated from rolls and solenoid-controlled, allowing cards to be picked at 900 per min.

7. Actuator assembly shown actuated. Reamer A and camshaft continuously rotate at 900 rpm clockwise; reamer B rotates counter-clockwise at 450 rpm. Camshaft and bail act to intermittently open and close gap between magnet and magnet lever, as magnet lever is moved left and right at point M.

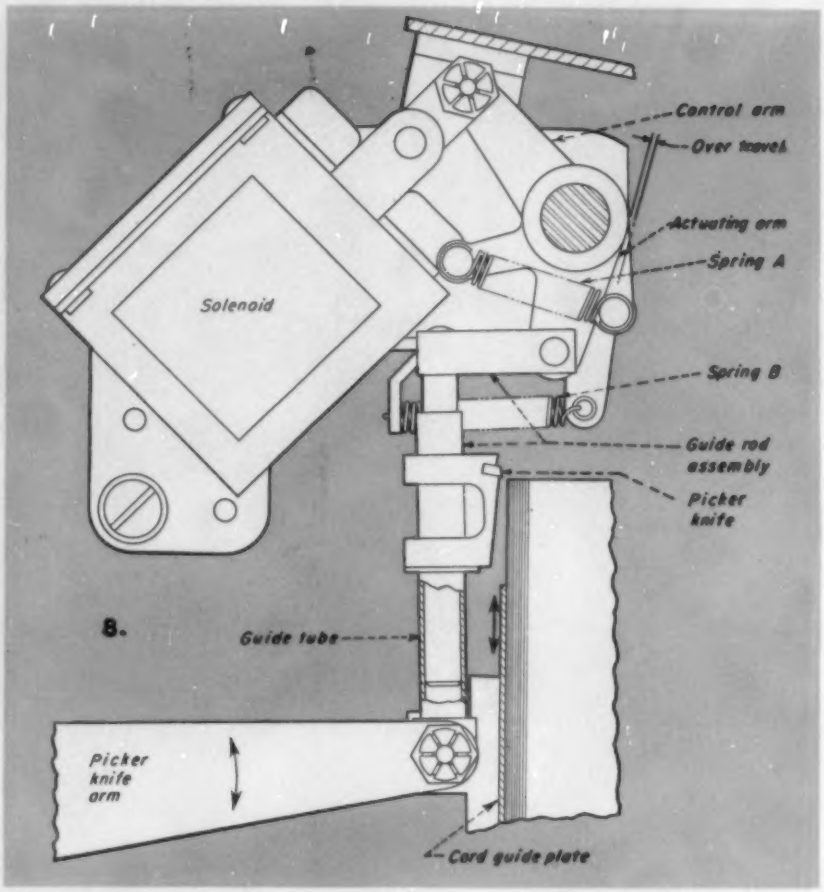
Pulse from decoder energizes magnet to hold magnet lever, preventing restoration by spring. Reamer A force push link upward, which through drive rods, transmits motion to print wire. Camshaft applies pressure at point N to overcome residual and disengage magnet lever from magnet link moves to right and restoration of push link. restored to normal position by either of two flutes on reamer B. Only 17 milisec elapses between instant that magnet link moves to right and restoration of push link.

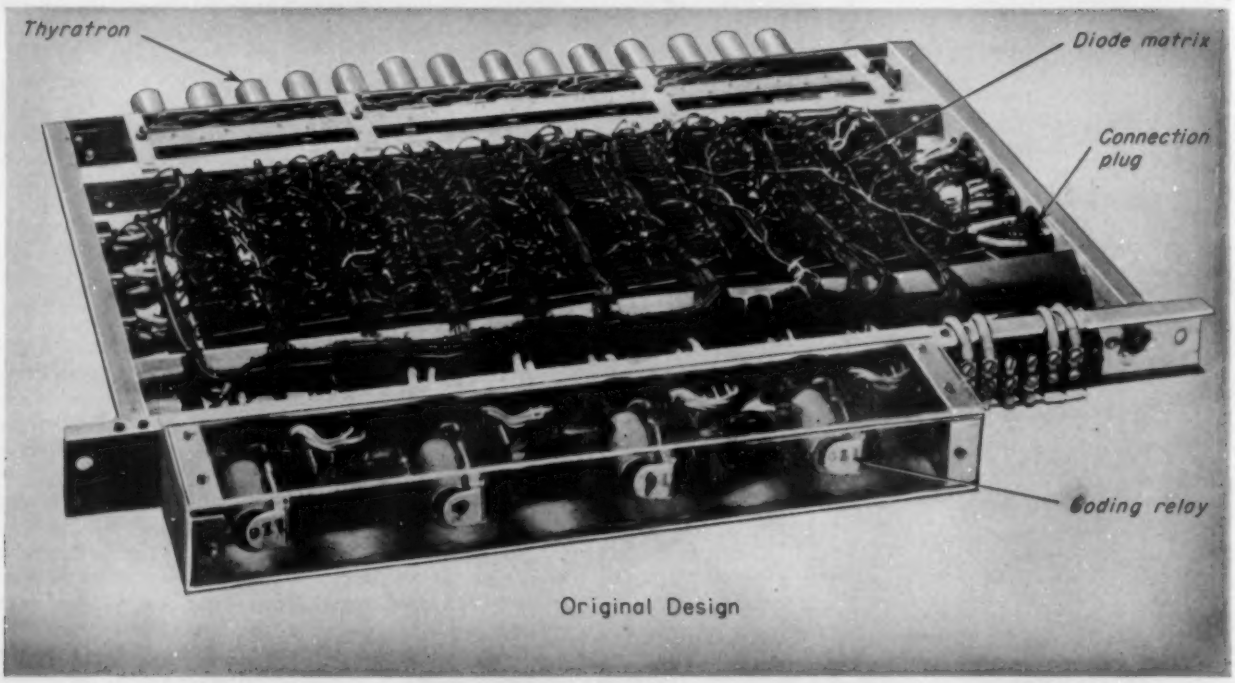
(continued on next page)

High-Speed Printer (continued)

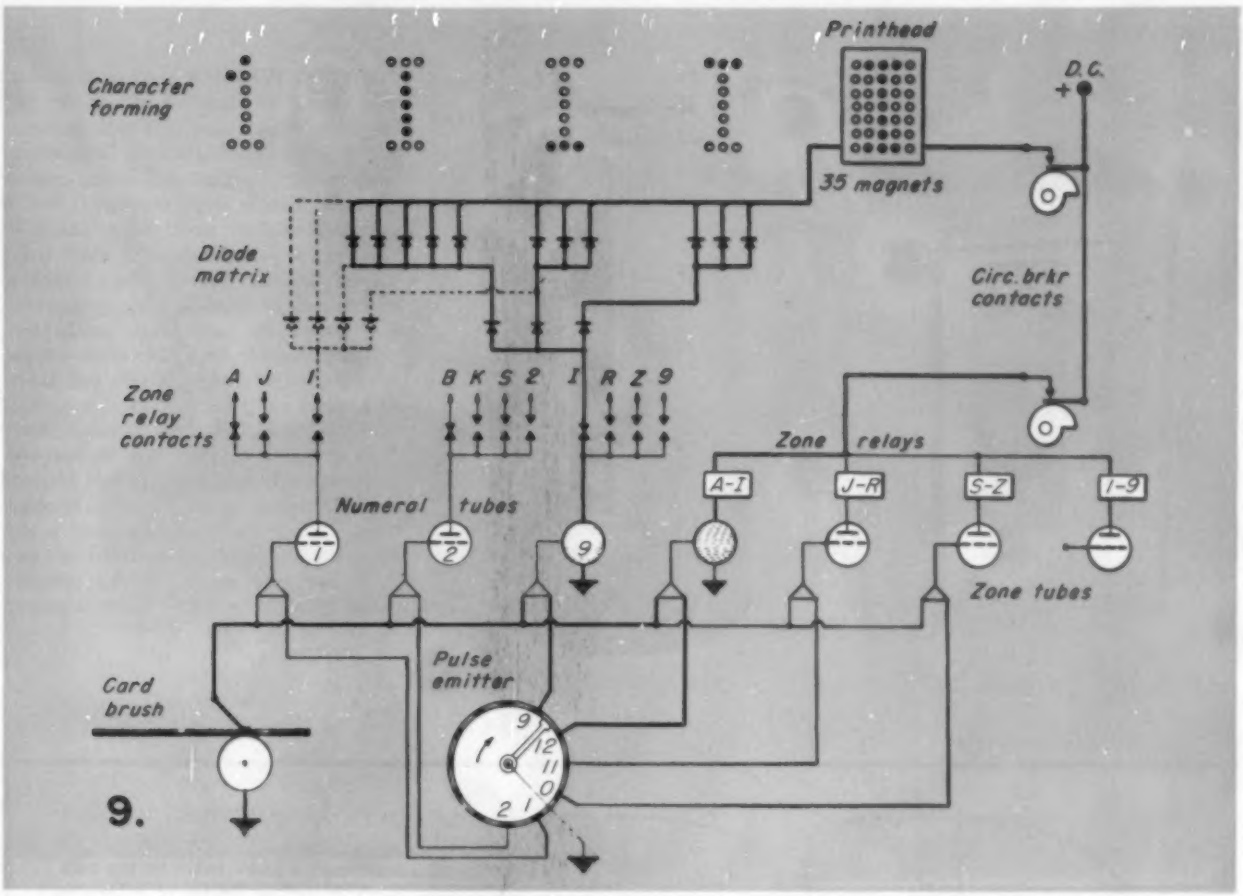
8. Picker mechanism shown retracted. Picker-knife arm drives card-guide plate and knife in continuous reciprocating motion as indicated. Energizing the solenoid forces control arm to rotate counterclockwise. Rotation is transmitted through spring A to actuating arm which urges guide rod assembly towards card. Thus, on down stroke of knife, card is picked and fed into roller system. When solenoid is de-energized spring B returns mechanism to retracted position.

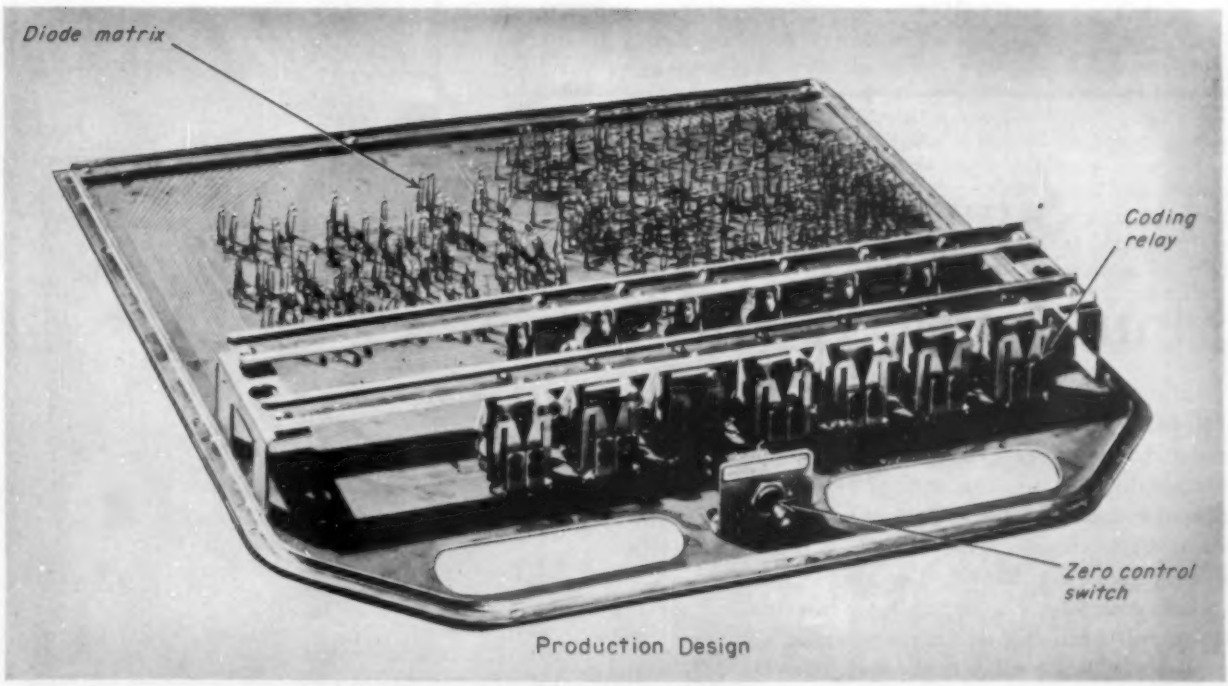
9. Electronic decoder represents additional step in accounting machine operation. Circuit shown is that used to feed letter I to printer in wire groups. Two thyratrons and appropriate relays are activated, as card is read by sensing brush, and diode matrix routes pulses to proper wire groups. Individual wire routing would require double the number of diodes.





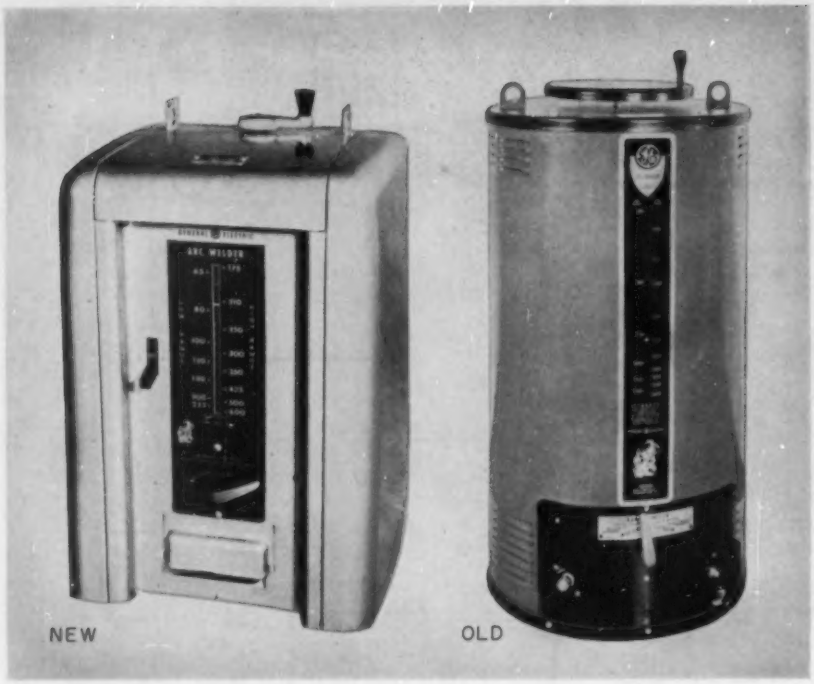
PRINTED CIRCUITS and germanium diodes greatly simplified the design of the decode chassis. Original design (left) used selenium cells, four relays and 14 thyratrons. Twelve of the thyratrons were replaced by relays, with two remaining tubes separately housed in an air-cooled section. Selenium cells were replaced by germanium diodes, smaller in size and suitable for



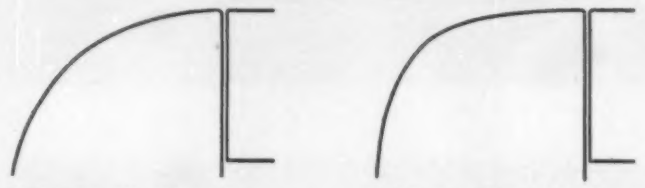


Production Design

printed circuitry. Zero-control switch is used to print or omit ciphers to left of significant figures. Chassis construction is particularly suitable for integration with plans for automatic assembly. Relay and diode leads can be machine inserted into board; with this method of assembly, connections are dip-soldered in less than five seconds.



NEW A-C WELDER and former model. Old model is identified by severe, unimaginative lines; new unit uses contours, highlights and lineal relations. Output connections are protected with cover; current adjusting handle (top) is shaped into a smooth continuous mass. Range handle is now part of plate design; dial width is increased for easier reading. Major form was determined by the operating mechanism. For uniformity, one large radius was adopted as guide for smaller radii—the radius is repeated in lever handle and knob. Old model was red with black trim, magnifying psychologically the radiated heat. New unit is hammerloid grey, in harmony with most industrial color schemes. Maroon calibration plate accents the grey. Housing finish used tends to obscure sheet metal imperfections or dents occurred in use. New unit is 8 in. shorter and occupies broader base area; weight is 23 lb greater because of larger frame.

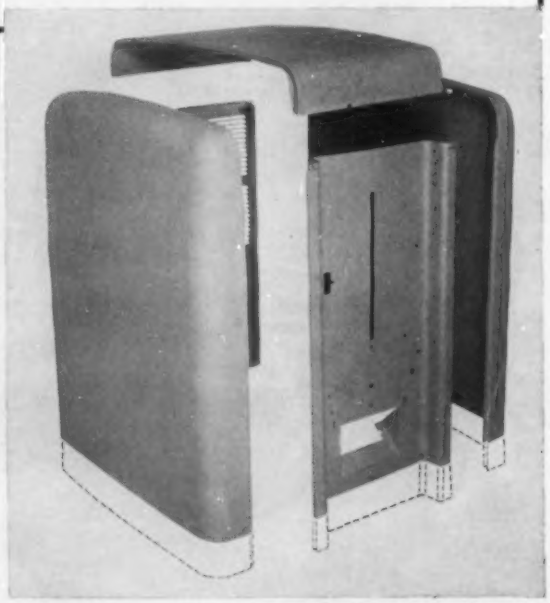


SIDE-COVER CURVATURE. Highlights have an appreciable effect on appearance. In development stage, a gentle radius on top edge of side covers created an illusion of bulge. As shown, a snap curve was applied, the radius sharpened and two bisecting radii flattened out, eliminating the illusion.

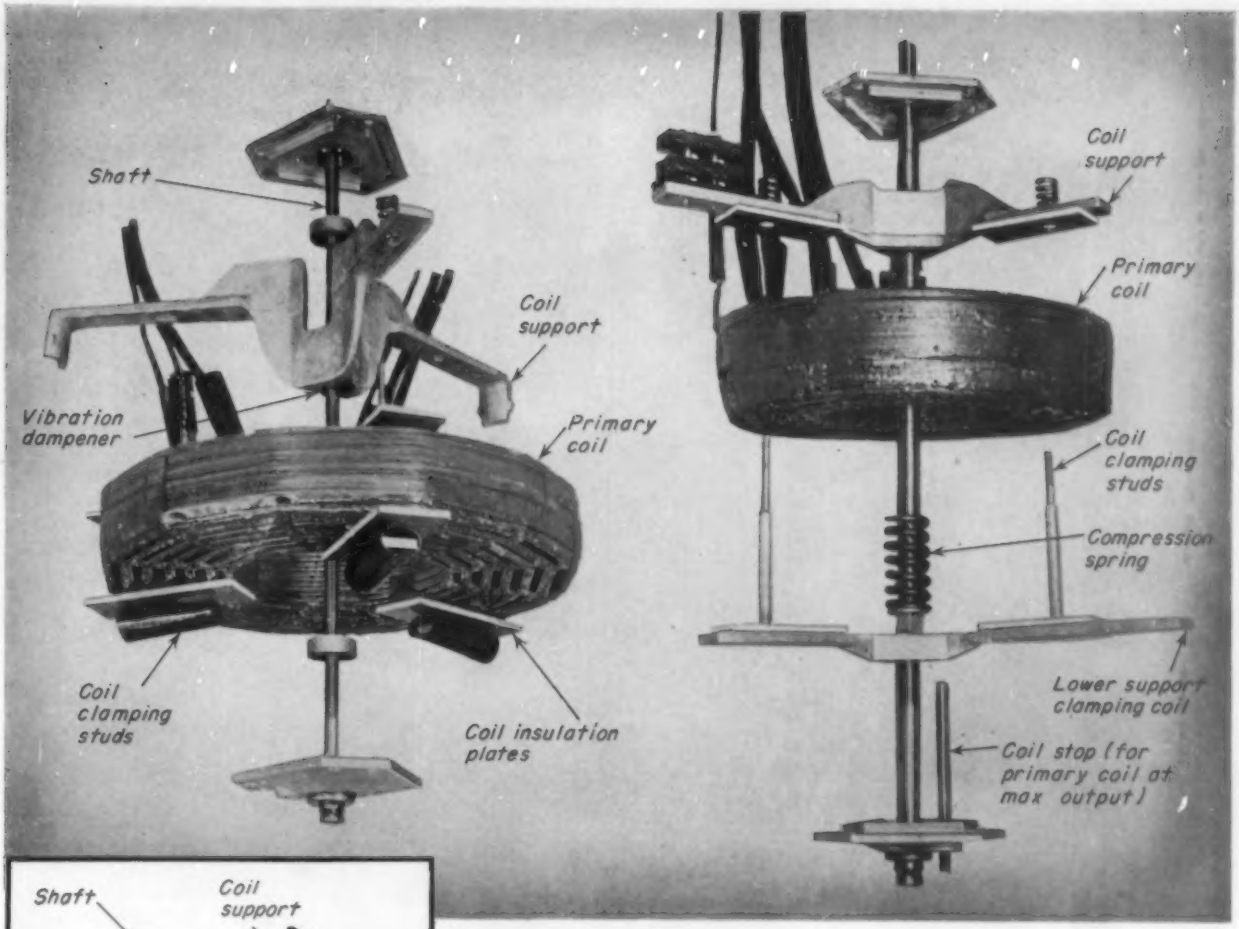
Simplified Functional Welder

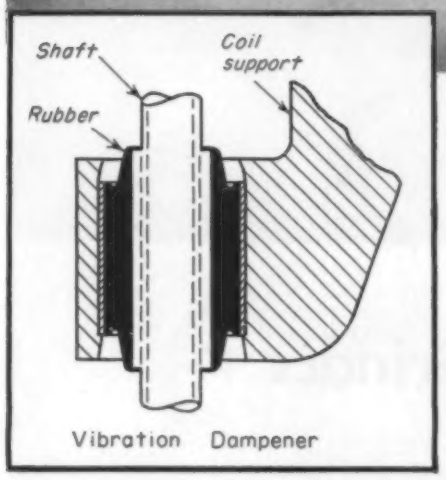
Redesign of the General Electric a-c welder has produced a unit that provides 1) simple, low-cost construction; 2) functionality; 3) attractive styling; 4) adaptable design for other company equipment. Project was accomplished by a 3-man team, including Mr. Lincoln W. Cross, supervisor of drafting, at the Welding Department, York, Pa.

Core punchings are reduced to two basic shapes; a rubber coil mounting minimizes vibration and wear; and aluminum coils are substituted for copper. Tooling for the housing is set up to fabricate three different size units. Servicing is made easier by the 4-sided cabinet, which replaces the cylindrical housing of the superseded model.

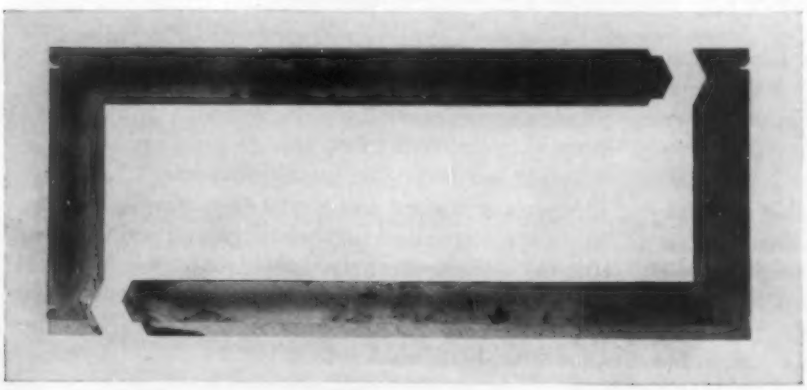


FLEXIBLE SHEET METAL die design allows manufacture of three different size models with substantially no additional tooling. Each model has same form and the standard edge contour.

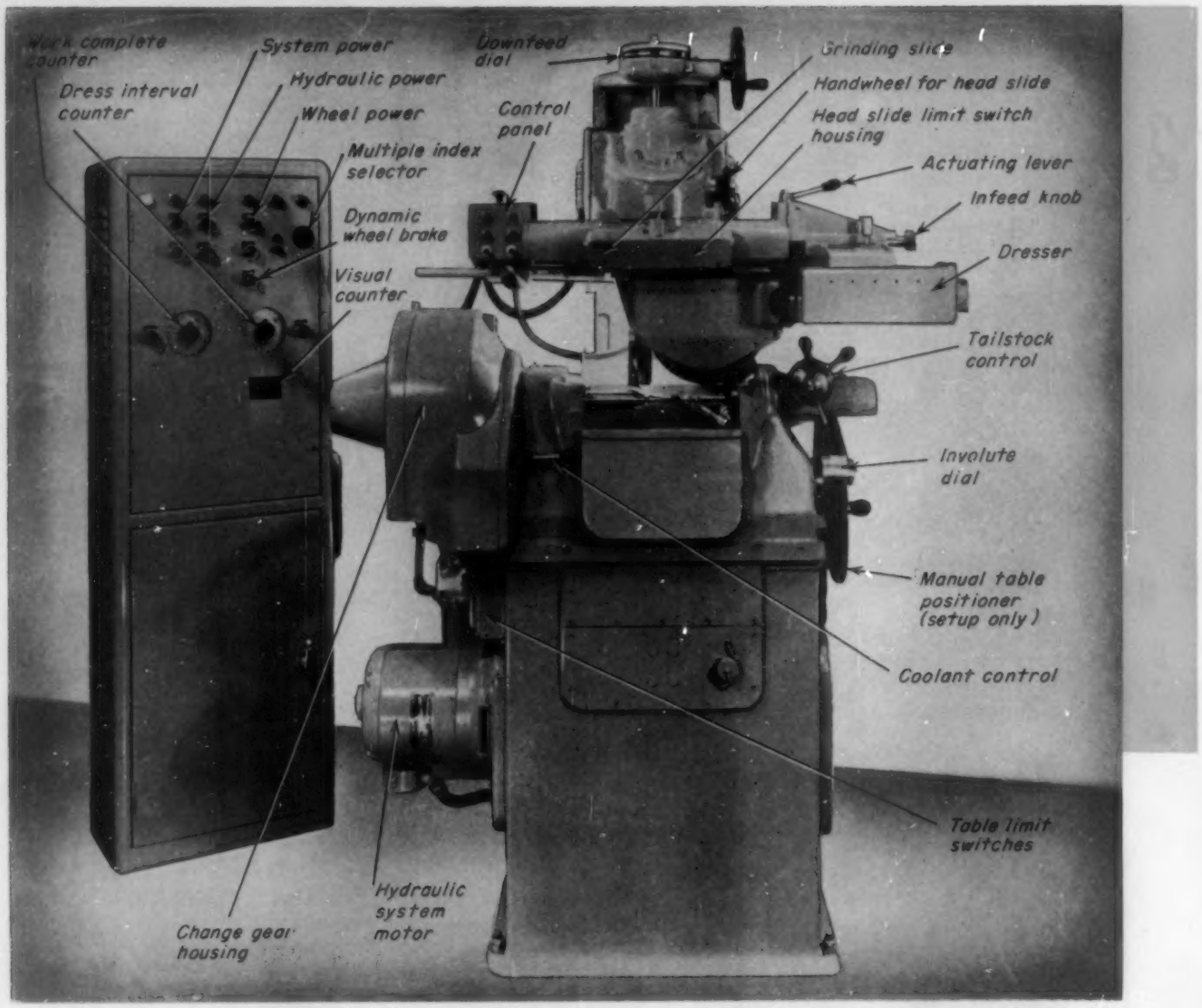




COMPARATIVE COIL AND COIL-SUPPORT ASSEMBLIES. Unit operates on moving primary coil principle—current output is determined by space created between primary and secondary coils, the primary moving up and down threaded shaft. In high-current welding a force pulsates between primary and secondary coils. In old design (right), to act against force a compression spring was applied against primary coil-support; spring pressure tended to bind the threads between support and shaft, making the shaft difficult to rotate. Moreover, mounting was expensive to manufacture and relatively complex. New welder uses a simple rubber vibration dampener of two basic components—coil support casting and flexible insert. The mounting provides a cushion; the pulsation between coils is almost completely absorbed by the primary coil mass. Less force is needed to move coil, and mechanical wear is minimized. The vibration dampener shown consists of an outer steel sleeve and an inner brass sleeve molded together in a rubber sandwich. ID thread on brass sleeve engages thread on actuating shaft.



CORE STACKING. Cores have been reduced to two basic shapes, which can be stacked for use in all three welder sizes. Two basic shapes are shown, the smaller punching on top.



Economical Gear Grinder

A gear grinder economically adaptable for short or long run production was the basic design aim of the Belock Instrument Corp., College Point, N. Y., in the manufacture of a new precision grinder for spur and helical gears. Requirements specified: 1) Rapid setup; 2) inexpensive tooling inventory; 3) compact, low-cost package; 4) automatic operation; 5) safety control; 6) easy maintenance.

Initial decision concerned basic grinding method—form or generating type. Generating was chosen because of flexibility. Less tooling is required; single dressing cam can generate an entire involute family of same diametral pitch.

Fast setup was achieved through an easily adjustable involute dial mechanism which replaces the standard master gear-and-rack operation; the diamond dresser is built-in the unit; production is stepped up by use of a multiple annular-form grinding wheel which can be dressed while work is loaded.

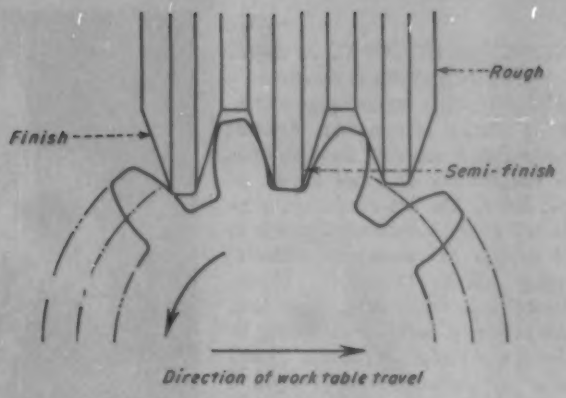
Indexing is accomplished by 3-change gear arrangement. Conventionally, four change gears are employed. A 25 per cent saving in gearing inventory is gained.

Automatic control includes a dress interval counter. Set to pre-determined number of ground teeth, control acts to station wheel at dresser head for necessary periodic dressing. Operator judgment error is eliminated.

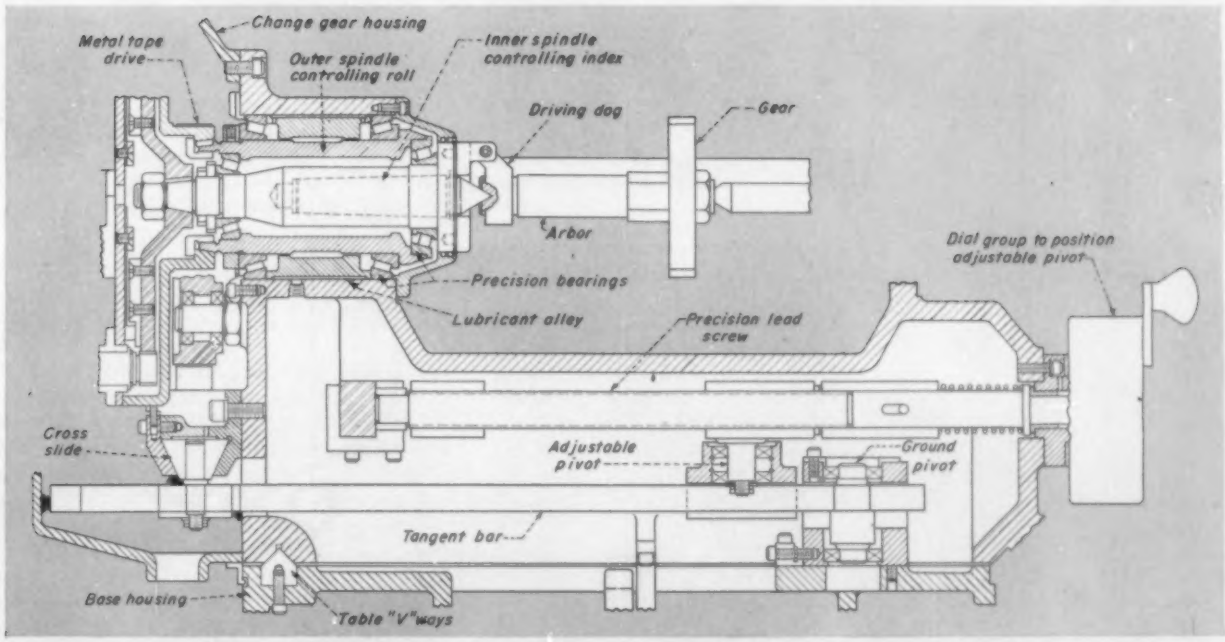
Cabinet housing all electrical controls is separate from unit, to facilitate maintenance.

GRINDER AND CONTROL CABINET. Simplicity of design is accomplished through elimination of master gears and racks, index plates and sine bars. Setup requires three adjustments—involute dial, completion and dress counters—and selecting change gears and dressing cam. Cam selection need be made only when pitch is changed. Two basic motions are table in-and-out and head-slide cross travel, both controlled by limit switches. Third motion—work roll—is driven by metal tape (not shown). Max pitch diameter is 7½ in., max face length 3 in. Head-slide can be positioned for up to ±35-deg. helix angle.

Grinder control panel has two operating push-buttons—grind and dwell. Dwell positions table out and wheel to right. Three work stops are light-indicated: work complete, inspection dwell and dress. Fourth light indicates grind. An emergency stop opens all electrical circuits. Control cabinet houses set-up controls only, for electrical, hydraulic and wheel-spindle power. Grinding wheel braking action can be effected by plugging or reversal of the motor. Work-complete counter measures off number of teeth ground and stops operation on completion of gear; dresser-interval counter is calibrated to work-complete counter. Counters are solenoid-actuated pawl and ratchets. Multiple change gear ratios can be used in conjunction with an index selector switch.



GRINDING WHEEL was wanted that would give longer wear, deeper cut and speed production. Conventional wheel has single form which takes full brunt of cutting load, and must be dressed between rough and finish operations, slowing down flow of work. Grinding wheel developed has three annular-rack forms, as shown. Rough form makes first cut; semi-finish follows, and finish form makes final cut on gear-piece. Thus, cutting load is distributed and heavier depth of cut possible. Wheel can be dressed after finish-cut, simultaneous with unloading of gear-piece. A wide variety of tip modifications can be accomplished by dial adjustment of the roll of the work spindle to the table travel.

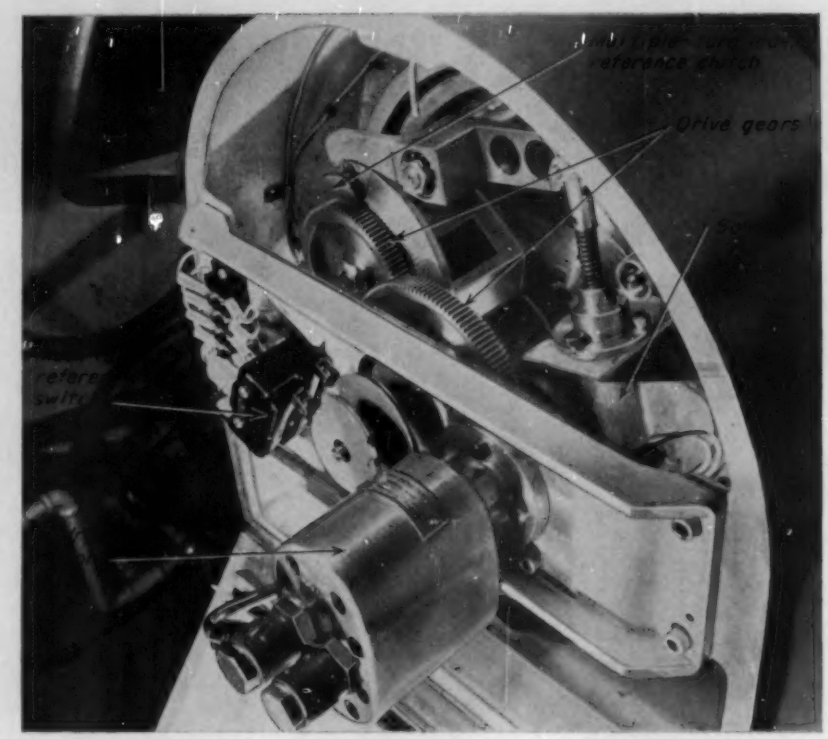


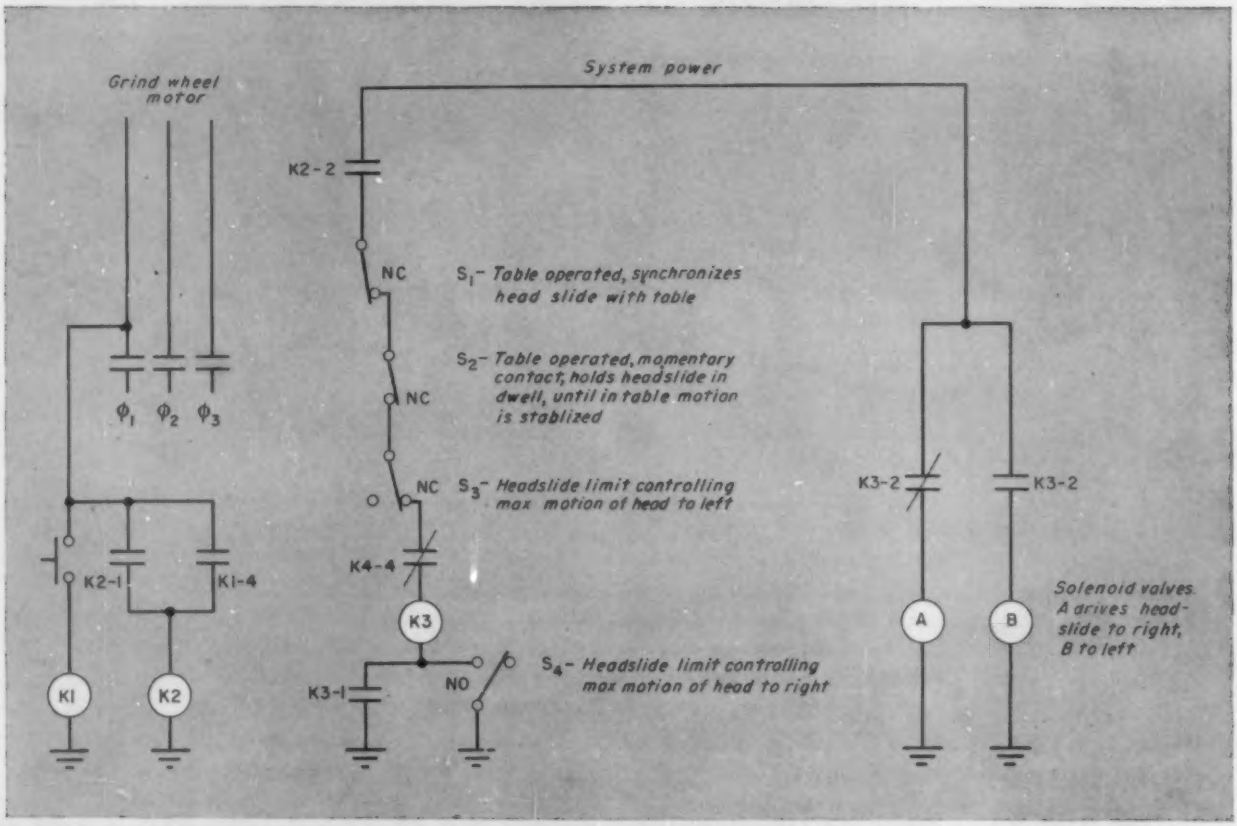
INVOLUTE GENERATING MECHANISM. Conventional master gear-and-rack setup requires high initial investment; production is limited by necessity of a different setup for each pitch gear. An involute generating mechanism was conceived to relate roll to table advance by a mechanical linkage system, as shown. Only a dial adjustment is necessary to set up for a given involute. The tangent bar is tied to the table and moves in a plane parallel to the table. Lead-screw is used to adjust pivot along length of bar, determining the amount of bar movement. Ground pivot is tied to bed. Pivot connects tangent bar to cross-slide which transmits bar motion to metal tape. The tape drives the outer spindle, producing work roll as table advances.

(continued on next page)

Gear Grinder (continued)

CHANGE-GEAR HOUSING. At end of each cycle, solenoid shown is energized by the table-limit switch, to disengage clutch, permitting rotation of cam-plate. Selector reference-switch is actuated, and two cams revolve the number of times pre-set on multiple index. On last revolution, stepping switch closes index switch circuit in control cabinet to de-energize solenoid, re-engaging clutch. Meanwhile, change gears located below drive gears shown have traveled necessary number of teeth, to index inner spindle for next tooth. Clutch control is used because of simplicity and firm action. Hydraulic motor was tried but gave unwanted elasticity, for use as positive ground reference. Change gears provide more flexible indexing than possible with master index-plate and pawl; plate has set number of index possibilities which cannot be modified. Use of three change gears in place of conventional four results from basic approach to indexing problem. Multiple-index selector is incorporated into unit, for use of high-ratio change gears to reduce tooth spacing error.

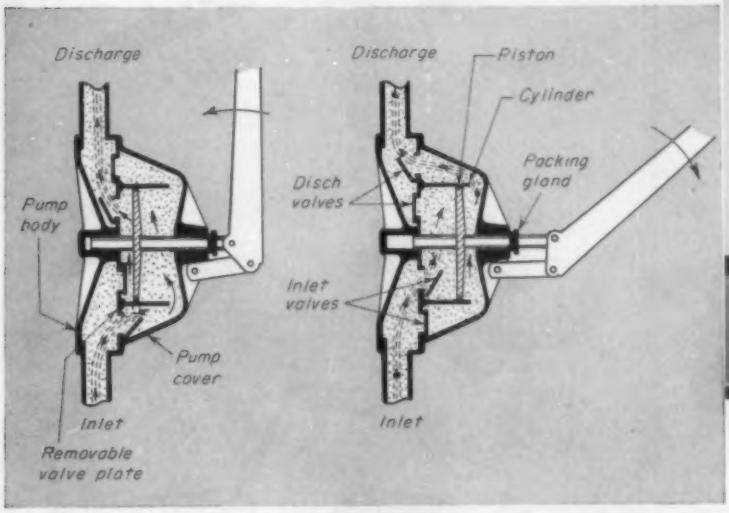




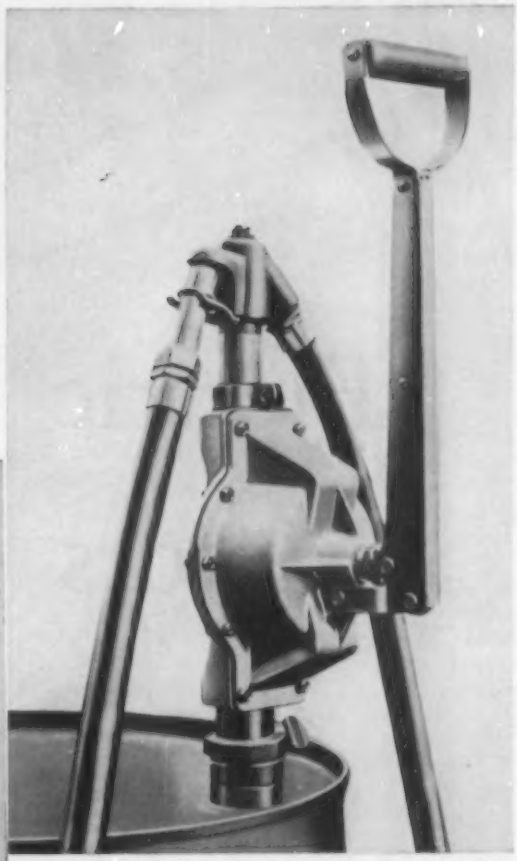
EXTRA SAFETY CONTROL protects against damage caused by a dead wheel. Should wheel power fail during operation, wheel is automatically positioned clear of work. Relay K2 is de-energized, opening contact K2-2, which de-energizes relay K3. Contact K3-2 is closed, energizing solenoid valve A, which drives head-slide to right, clearing work. Electrical safety interlock system is setup so machine will automatically stop, should operator inadvertently push any control button on grinder.

Hand Pump With Double Acting Piston

While a diaphragm-type hand pump requires less manual effort for a given rate of flow, a double-acting piston pump is basically easier to manufacture. Objective behind the development of this new pump by John Wood Co., Muskegon, Mich., was to design a piston pump requiring less manual effort, without sacrificing cost and ease of manufacture.

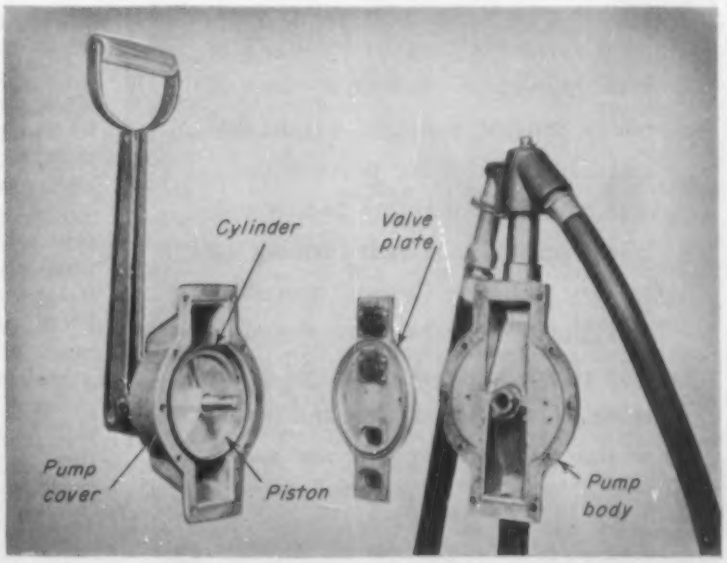


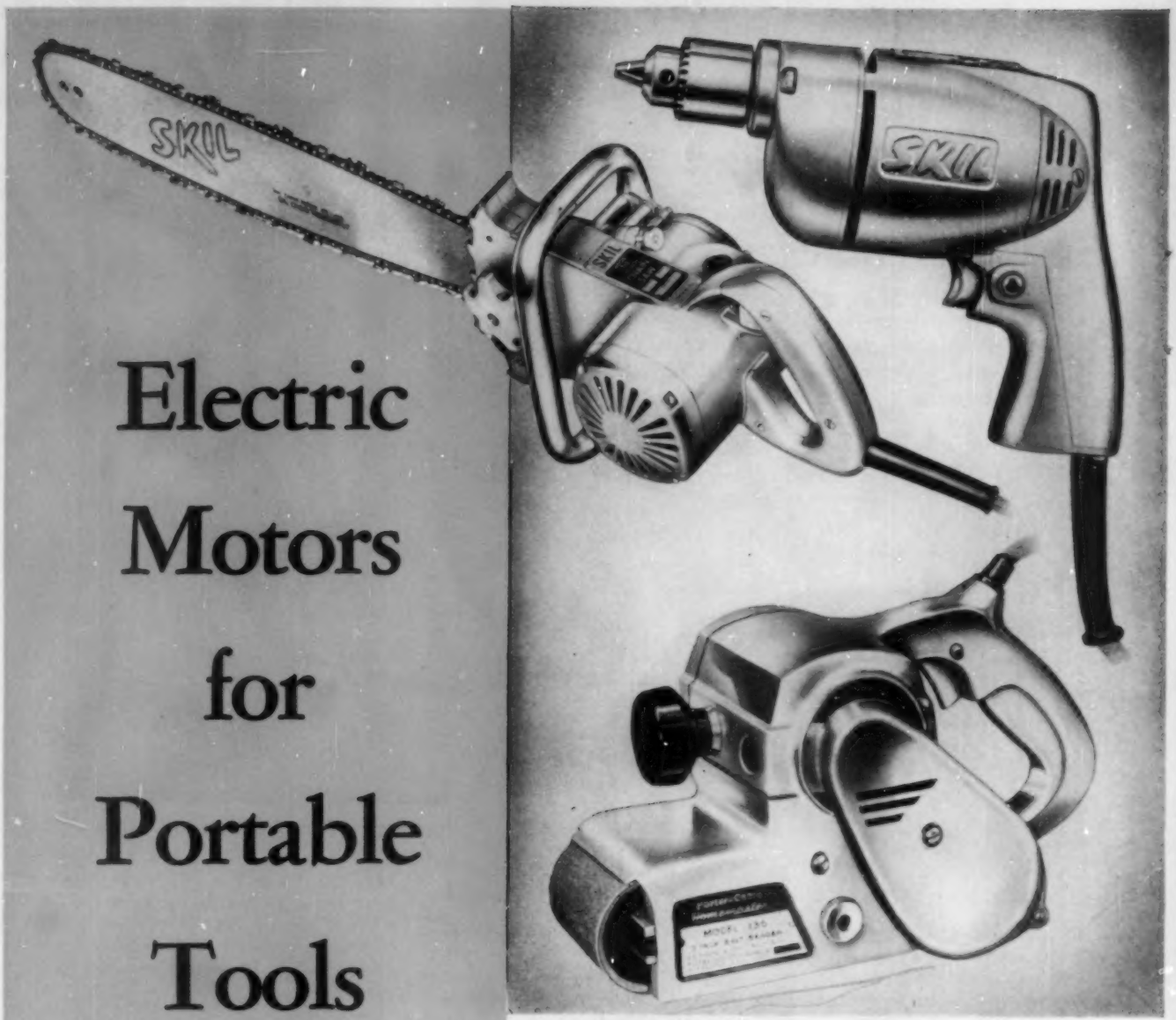
FLOW DIAGRAM illustrates simplicity of pump design reducing manufacturing costs. Cylinder is used to guide flow path, obviating any additional walling. Lower inlet valve and upper discharge valve are part of 1-piece assembly—the valve plate. In previous model pumps, these two valves have been located at far end of cylinder, to require separate assembly.



TO OVERCOME relatively sluggish response of double acting piston pump, the bore-to-stroke ratio was increased to 3-to-1, and handle lever given 16-to-1 ratio. Effectively, for given rate of delivery, same amount of effort is required to operate double-acting pump as conventional diaphragm pump. Pump can deliver up to 20 gal per minute.

TO DISASSEMBLE for servicing, the pump body need not be removed from suction or discharge lines, and handle and packing gland may be left intact. Removing ten bolts will separate the unit into body and cover as shown. Valve plate is detached from pump body by removing two screws. Pump can be applied to wide range of liquid-types. Only packing gland is made of organic material—asbestos fibre—and other parts may be fabricated from a selection of metals. Pump body, cover, valve plate and piston can be made from die-cast aluminum or zinc, or from stainless steel by shell-molding. The cylinder may be either brass or stainless steel tubing. The rings are cast iron; valve flaps and seats are stainless steel.





Electric Motors for Portable Tools

For high-speed universal motors, which provide the light weight and small size needed for portable tools, standard motor parts are usually supplied with the tool itself forming the motor housing. Design procedure and data on typical designs presented here provide a ready means of determining optimum diameter and length of stator for given power and speed.

J. H. KARR
Assistant Chief Engineer, Robins & Myers, Inc.

COMPACT, LIGHT-WEIGHT SOURCES of power are provided by universal series-wound motors to drive portable electric tools. An important advantage of these motors is that they can be used with either a-c or d-c power, but the principal advantage is that the high speed of the universal motor reduces the size and weight of the drive. Complete universal motors are furnished in a large variety of forms and frame sizes with ratings ranging from 1/1000 hp to 1 hp. Speed ratings are usually 5000 rpm or higher and idle speeds of 15,000 to 20,000 rpm are common.

Most universal motors are furnished as motor parts, consisting of field assembly, armature, and brush mechanism, such as shown in Fig. 1(A). The purchaser assembles these parts into a housing of his own design. The field circuit and the armature circuit are connected in series as shown in the electrical diagram in (B). The motor shown powers a 6-in. portable saw. Since the motor speed is too

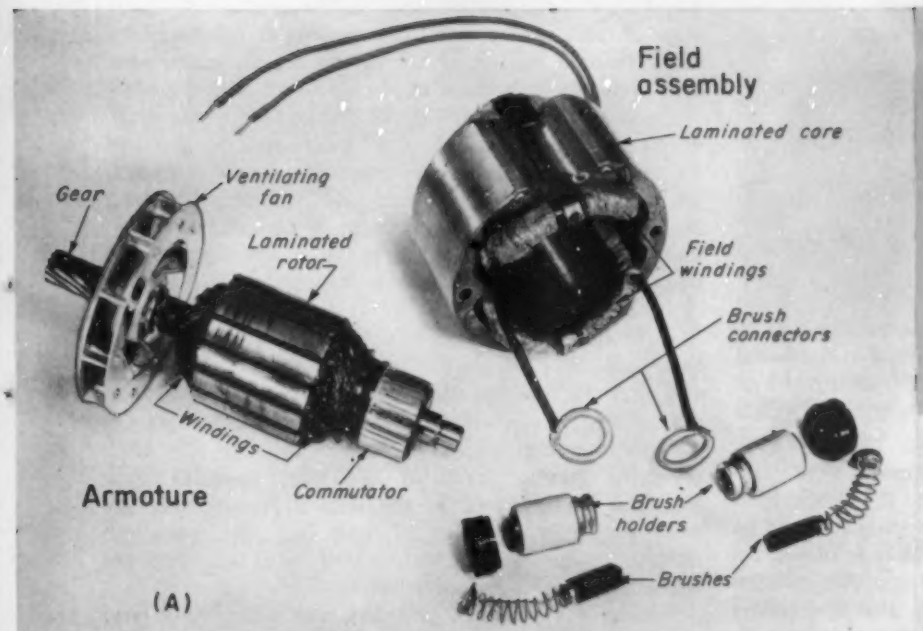
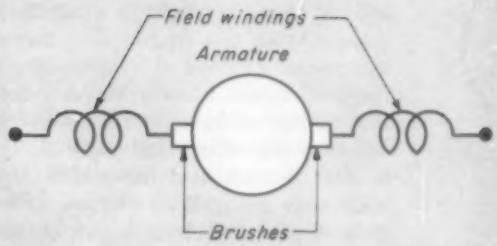
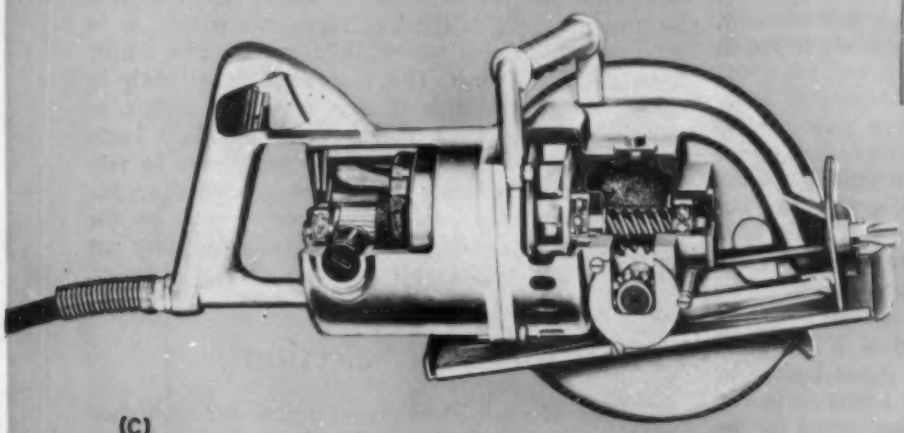


Fig. 1—(A) A typical set of universal motor parts as furnished for assembly into portable-tool housing; this motor is for a 6-in. portable saw.

(B) Field and armature are connected in series; high rotational speeds provided give compact, lightweight motors.





(C) Cutaway view of industrial-type portable power saw by SKIL Corp. using a universal motor; gearing reduces speed of motor to proper saw speed.

high for directly driving the saw blade, a gear reduction is used to obtain the proper saw speed as shown in (C). With the exception of a few such applications as grinders, blowers, routers, vibrators, and the like, speed reduction through gears or belts is usually required.

SALIENT POLE MOTORS. The majority of motors for portable tools are of the universal, two-pole, salient-pole construction, such as shown in Fig. 1(A). In some cases the field coils are wound, insulated, and then assembled onto the two projecting poles. In other cases these coils are wound directly on the poles. Armatures are random wound into the slots, as contrasted to inserting pre-wound coils in large motor armatures, to provide one, two or three coils per slot. The number of coils per slot fixes and is equal to the ratio of the number of commutator segments to armature slots. A large ratio is preferred for best commutation, maximum brush life, and minimum radio interference. The smallest usable ratio results in lowest armature cost.

Connections to the commutator are usually made in a manner to give the effect of shifting the brushes, thereby improving commutation and general motor performance. The brushes can then be located midway between the poles to conserve space in the housing design. Connections are usually made as shown in Fig. 1(B) with the armature connected through the brushes between the two pole windings. Theoretically, rotation of the motor can be reversed by reversing connections to either the field windings or the armature. Usually this is not practicable because the armature is wound and connected for optimum performance in one direction of rotation only. In such cases, operation in the incorrect direction results in poor commutation and a marked reduction in motor output.

DISTRIBUTED FIELD MOTORS. Some universal motors, particularly in the larger sizes, use a distributed type field instead of the salient-pole, concentrated-coil type. An ordinary induction-motor field is similar.

Pre-wound coils are inserted into uniformly-spaced slots

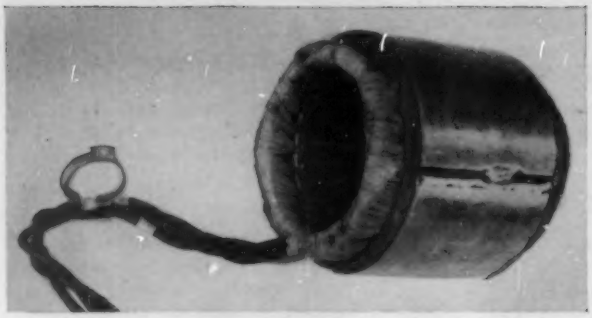


Fig. 2—Distributed-type field provided with a compensating winding. This type is used in heavy-duty applications which require reversible motor. Ring on lead is for brush connection.

and are usually arranged in a pattern to result in two pole-groups. With this type of field assembly it is possible to incorporate a second or compensating winding centered on the brushes and midway between the main windings, for the purpose of balancing the effect of armature reaction and thus controlling commutation. It is then unnecessary to shift brushes, and the motor is particularly useful in heavy-duty applications which require reversible operation such as pipe threaders. A distributed-type field assembly, provided with a compensating winding, is shown in Fig. 2.

General Characteristics

The universal motor operates satisfactorily on either alternating or direct current, though it usually does not display the same performance characteristics. It is ordinarily designed to operate at several times maximum speed of a 60-cycle induction motor. For example, when an induction motor is wound with a single pair of poles and operated on 60 cycles, maximum speed of 3600 rpm is obtained. The speed of a series motor is not limited by number of poles or frequency as is an induction motor, and it is possible to design for speeds best suited for the application. Speed is usually not limited by motor design but rather by mechanical limitations of rotating elements such as gears, bearings, commutators, ventilating fans, etc.

Motor ratings are invariably limited by heating and ventilation. The basic problem is simplified because of the high motor speed. At the same time, high speeds present problems such as vibrational stresses in fans and noise resulting from movement of high velocity air through housing openings. For effective performance it is essential that ventilating fans be carefully baffled or shrouded.

Two broad classifications of ventilating systems are used: radial-flow and axial-flow. Satisfactory designs are possible with either, and the selection of the type to use is usually made on the basis of personal preference together with limitations which may be imposed by functional features of the housing design. In axial-flow systems the air may be discharged radially by providing suitable baffles to direct the air after passing through the fan. It is necessary in any case to shroud or baffle the fan to prevent re-circulation of air around blade tips.

Disadvantages of universal motors are: (1) relatively noisy motor operation, (2) brush and commutator maintenance requirements, (3) potentially less reliable armature than for squirrel-cage induction motors, and (4) the radiation of radio interference from sparking at brushes. Universal motors are not ordinarily applied to continuous-duty applications because of limited brush life.

Brush life of 50 hours may be acceptable for one application whereas 1000 hours or more may be required for another. For maximum brush life careful attention must be given to such factors as concentricity of commutator surface and bearing journals, condition of commutator surface, brush-spring pressure, brush grade and size, dynamic balance, and maintenance of proper bearing clearances.

Performance curves of a typical universal motor applied to a common portable tool are shown in Fig. 3, which compares the characteristics of the motor when used on ac and dc. The rpm and torque were measured at the tool spindle shaft which was driven through 3.54 to 1 reduction gearing. Probably the most important performance characteristic to the user is the speed-torque curve shown in (A). The relatively high idle speed and drooping nature of the speed with increasing load are characteristic of universal motors.

Ratings for portable tools are commonly for a load which results in 50 to 55 per cent of the idle speed. The rating is usually in terms of the current input at that load, and is rarely in terms of horsepower output, as in the case of induction motors. Idle speed is also usually a portable tool rating. This is necessary, particularly in cutting applications such as drills, saws, and sanders, in order to insure effective tool performance at light loads.

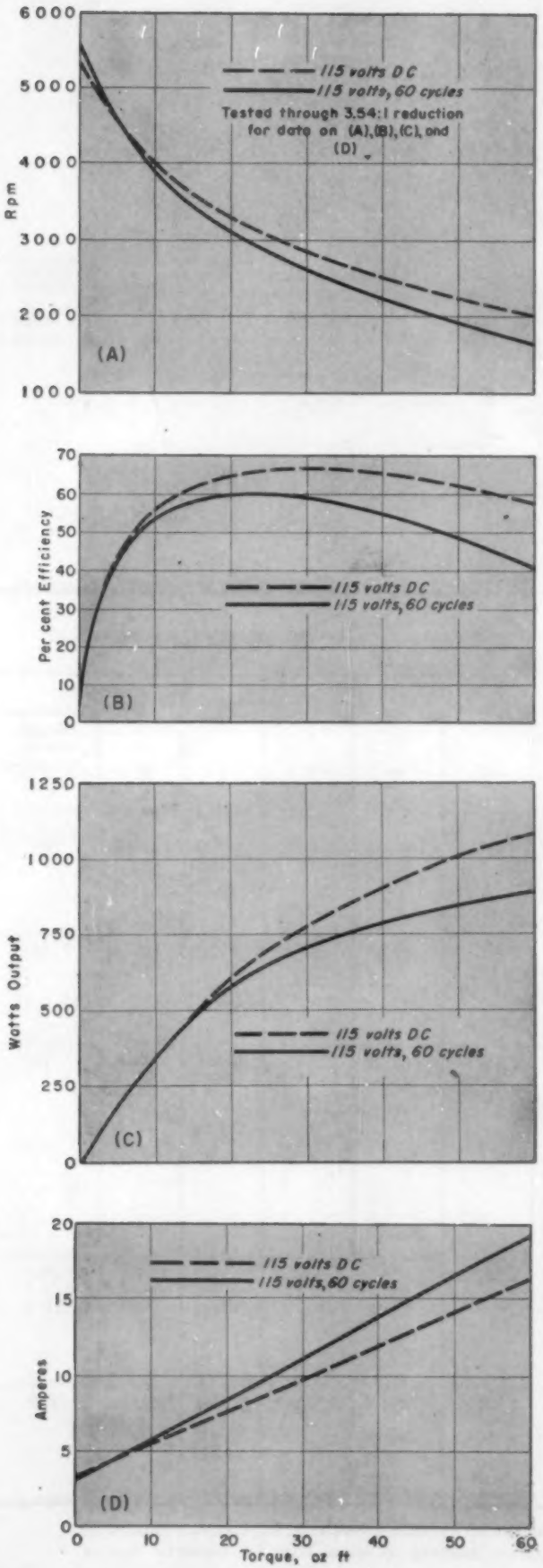
The use of current as a basis for rating may be misleading, because it tends to penalize good design. For example, users sometimes choose between tools on the basis of current ratings. A high current rating may not reflect the best product but may indicate a poor design.

Factors in Motor Selection

Selection of a suitable motor for a particular application may be made in various ways. The background and experience of the tool manufacturer may be such that he is in a good position to estimate motor requirements. In any event, the motor manufacturer usually has had a wide experience and is in a position to make reliable recommendations. If the application is something new, there is no particular problem provided a reasonable estimate can be made of power and speed requirements, duty cycle and expected life.

Selection of motors may also be based upon industry standards for universal motors and upon past experience in relating motor performance to motor size.

NEMA STANDARDS. Standards of the National Electrical Manufacturers Association have contained some dimensional data relating to universal motor parts since 1929. In 1949 they were revised to include standardization of many items significant to the user. The standards are reproduced in detail in Fig. 4. The dimensions which have been standardized are only those of particular significance to the user such as stator diameter, commutator diameter, location of commutator with respect to stator, stator stacking plus coil overhang, maximum bearing bores, brush holder diameter and location, axial brush length, and mounting-screw locations and size.



It is the intention of the standards to leave the motor designer with freedom to exercise his ingenuity and obtain the ultimate in motor performance. Thus there are no standards on such details as armature diameter, air gap, core length (except as it is influenced by the length of core plus coil overhang), number of armature slots, number of commutator segments, or circumferential dimensions of brushes. It has been found impractical and undesirable to attempt to standardize shaft extension and ventilating fan details.

The NEMA Standards do not assign motor ratings to frame sizes. Such assignments would be of little significance because of the variations in performance requirements of different applications, and principally because the design of the motor housing, including the ventilation system, is the responsibility of the purchaser of the motor parts.

UNDERWRITERS' LABORATORIES. Since listing by Underwriters' Laboratories is usually desired and sometimes required, it is important that the portable-tool manufacturer as well as the motor manufacturer be familiar with these requirements. At present they are covered by the Laboratories' Standard for Motor-operated Appliances, dated March 1952, and Supplementary Proposed Requirements for Industrial-type Portable Motor-operated Tools, dated February 1950. These requirements do not deal directly with motor selection or application, but with features relating to personal safety and fire prevention.

Some of these features indirectly affect motor selection. A typical example is the temperature-rise limitation at rated load. It is possible to apply a motor to a device that will perform the service for which it is intended but which, in doing so, operates at temperatures beyond the limiting values set up by UL as being acceptable. If it is impossible to meet the requirements by improved ventilation, it becomes necessary to apply a larger motor.

Determining Motor Size

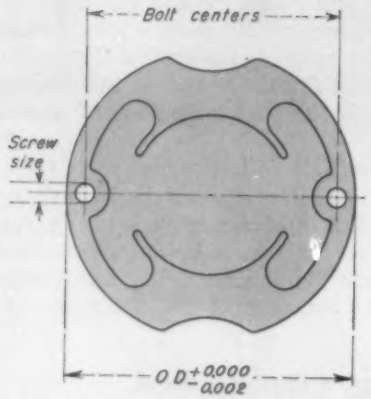
The problem of relating motor size to performance is a difficult one because there are so many variables involved. The basic principle applying here is that the volume of a motor is proportional to the ratio of motor output to speed:

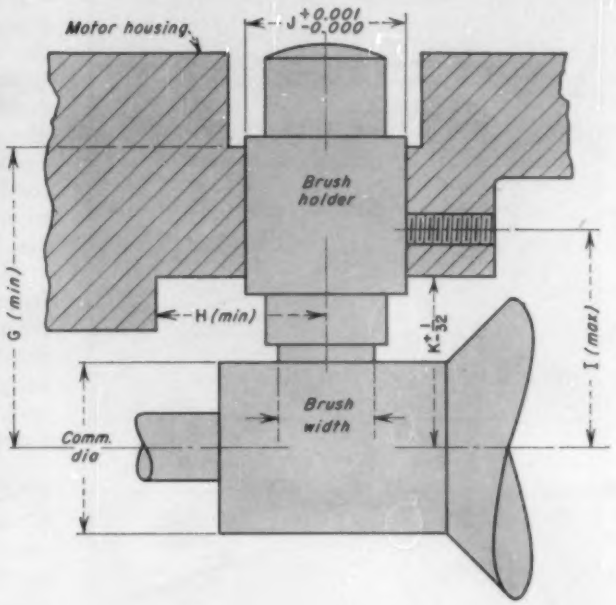
$$LD^2 \propto \frac{W}{\text{Rpm}}$$

where D = outside diam of stator in inches

L = length of field lamination stack in inches

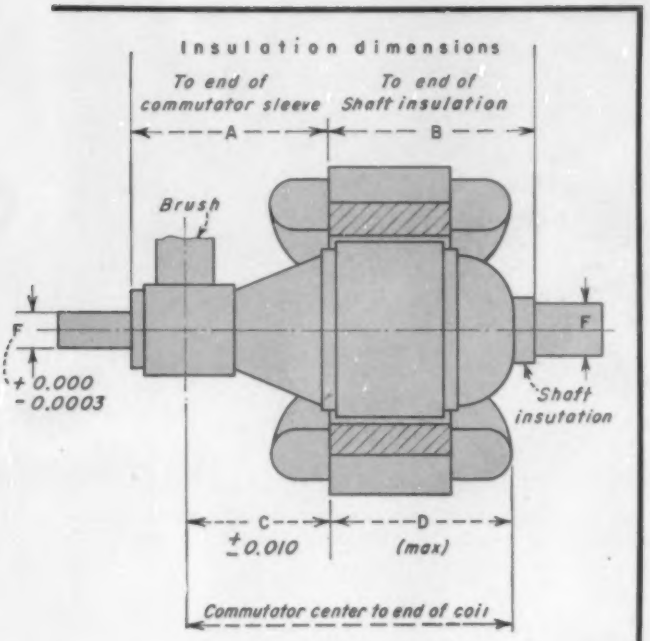
Fig. 3—Typical performance curves of a 115-volt universal motor applied to a common power tool. D-c ratings (dashed-lines) are compared with a-c ratings (solid lines), and rpm and torque figures are obtained from the spindle shaft of a tool driven through 3.54 to 1 reduction gearing. (A) Speed-torque curve shows characteristic speed droop with increasing load. (B) Motor efficiency versus motor load. As the motor load is increased from zero load the efficiency rises to a maximum at approximately one-third maximum load then decreases as the load is increased. (C) Watts output vs motor load. Because the efficiency is not constant the output does not increase linearly with the applied load. (D) Motor current vs. torque. Torque is directly proportional to current.





Laminations for 2-hole bolting			Commutator and Brush-Holder							
OD	Bolt Centers	Screw Size	Brush Width	Comm. Dia.	G	H	I	J	K	Maximum Brush-Holder Set Screw
2.125	1 53/64	#6	3/16 1/4	7/8	1 1/8	27/64 15/32	15/16	0.532 0.625	1 3/16	#6
2.437	2 1/8	#8	1/4	7/8	1 1/8	15/32 1/2	15/16	0.625 0.687	13/16	#6
2.875	2 7/16	#8	1/4 3/8	1	1 13/32	15/32 1/2	1 7/32	0.625 0.687	15/16	#8
3.687	3 1/4	#10	3/8 1/2 3/4	1 1/4	1 27/32	1/2 5/8 25/32	1 5/8	0.687 0.875 1.125	1 1/8	#10
4.375	4 1/8	#10	3/4 1 1/4	1 5/8	2 9/32 2 13/32	25/32 29/32 1 1/32	2 1/16	1.125 1.437 1.687	1 5/16 1 7/16	#10

Fig. 4—Important design dimensions for universal motor parts as set by NEMA standards. For complete dimensions see NEMA Standard MG1-7,1.t. Standard motor ratings are not assigned to frame sizes for universal motors.



Stator and armature dimensional relations

Insulation Dimensions				Bearing Journal Dia.	
A	B	C	D	E	F
29/32 31/32	1 1/2 1 3/4 2 2 1/4	43/64 45/64	1 7/16 1 11/16 1 15/16 2 3/16	0.2363	5/16
1 1/32 1 5/32	1 1/2 1 3/4 2 2 1/4	49/64 53/64	1 7/16 1 11/16 1 15/16 2 3/16	0.2363	3/8
1 5/32 1 9/32	1 9/16 1 9/16 1 19/32 1 13/16 1 31/32 2 1/16 2 11/32 2 33/32	55/64 59/64	1 1/2 1 3/4 2 2 1/4	0.3151	3/8
1 1/2 1 5/8 1 13/16	2 3/32 2 15/32 2 27/32 3 7/32 3 23/32	1 5/32 1 7/32 1 19/64	2 2 3/8 2 3/4 3 1/8 3 5/8	0.3939	5/8
1 15/16 2 3/16 2 7/16	2 13/32 2 25/32 3 5/32 3 17/32 4 1/32	1 27/64 1 35/64 1 43/64	2 5/16 2 11/16 3 1/16 3 7/16 3 15/16	0.4724	7/8

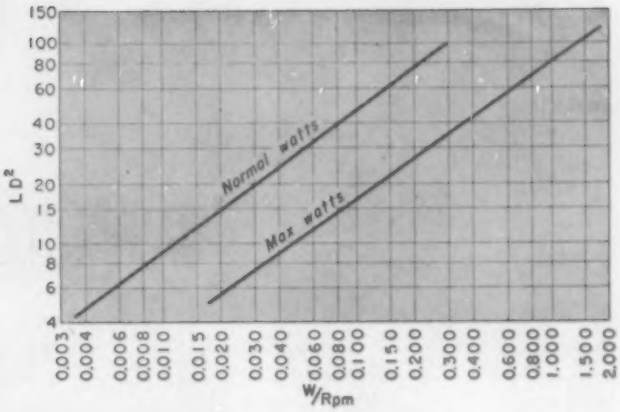


Fig. 5—General relationships between motor performance and motor size based on an analysis of many typical motor designs. Text describes use of this chart for determination of approximate motor size ($L D^2$) as related to the ratio of watts output to speed in rpm ($W/_r$).

W = output in watts

Rpm = motor-shaft speed in rpm

An analysis of many universal motor designs, shown in Fig. 5, can be used to predict approximate motor size from the ratio of desired output and rpm. For example, a motor required to develop a normal output of ¾ hp or 560 watts at 12,000 rpm has a ratio of 0.0466; this corresponds to a value of 27 for LD^2 for a normal rating.

A choice of stator diameter must be made before the length of stack can be calculated. Stator diameters which are standard in the industry are shown as dimension OD in the table of Fig. 4. The choice of diameter will be determined by mechanical-design proportions which are desired in the housing, together with consideration of proportions to give the best motor design. If a diameter of 3.687 in. is selected in this case, the stack length will be $27/3.687^2$ or 1.98 in., nominally 2 in. If a diameter of 3.187 in. had been chosen, the stack would be 2.65 in. which would result in a poorly proportioned motor. Similar calculations can be made starting with maximum watts output and operating speed.

There are many combination of field and armature windings which will give approximately the required motor output and speed. The best combination usually represents a compromise between performance, commutation, brush life, shape of speed-torque curve, distribution of losses between field and armature, duty-cycle, and requirements of the application. While data given here relating to determination of motor size is typical, the motor user may be justified in departing widely from the given values for any specific non-typical application.

EDITOR'S NOTE—Induction motors are used in only a few portable 60-cycle power-tool applications. One of the basic reasons for this is the relatively slow rotational speeds which are limited, for practical purposes, by the 60-cycle power-supply frequency. This limitation can be removed by using induction motors which operate on high-cycle power, the frequency of which is several times that of the normal 60-cycle supply. A forthcoming article will describe the characteristics, physical data, and applications of induction motors designed to operate from high-cycle power.

SILVER is bonded to phosphor bronze by silver solder. In this process, clamps hold these together during heating. When bonding is complete, and the laminate is cooled the clamps are removed and solder overflow along the sides is milled off.

The Use of CLAD METALS

A combination of properties in one unit can be effected by the use of metal laminates. The workability of clad metals and the variety of claddings increase the range of applications of rolled-on metal-to-metal laminations. Types of cladding, design functions, applications and limitations are described.

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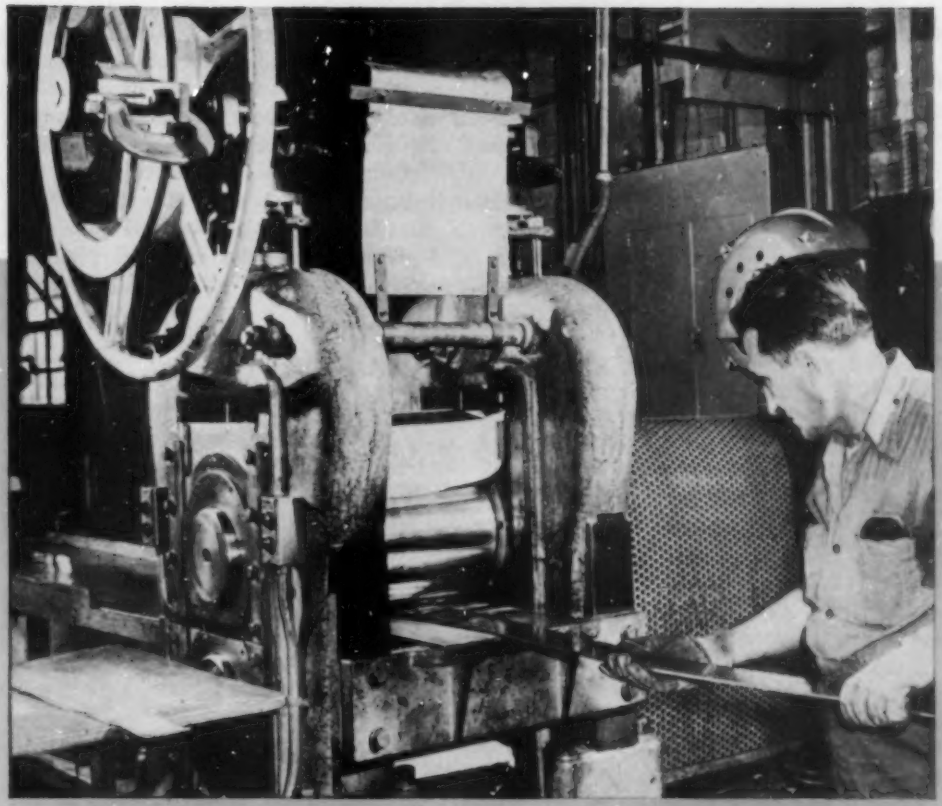
CLAD METALS are laminates—combinations of two or more metals intimately joined together—to supply properties not found in any one of the metals of the composite. The most useful property of each metal can be added to the most useful property of another. Where electrical conductivity coupled with high strength and magnetic properties is desired, copper clad on steel, or silver clad on steel, can be specified.

Clad metals are made by several methods. More than twenty different processes are described in the literature here and abroad; five systems are in general use today. These are: pressing, casting, direct rolling, sintering, and deposition. Regardless of the method used, the result is a composite material which cannot be separated by physical means short of complete destruction.

Clad metals can be drawn, rolled, spun, bent, twisted, heated, quenched, punched or otherwise formed. Many of the properties of clad metals can be predicted by the properties of their components before bonding. Strength and density are usually an arithmetical average of those values of the components. More complex calculations are



THE CLAD BAR is cold-reduced in a breakdown mill. Reductions sometimes require intermediate anneals. Tests throughout the operation insure good quality control.

FINAL reductions are made on finishing mills. The rolls are ground to give the clad bar a high finish. The composite material receives a uniform temper. Because of the processing involved in this operation, mechanical properties are excellent.

required for measuring ductility, electrical and thermal conductivity.

The corrosion-resistant characteristic of a clad metal is the same as that of the solid metal of which the surface is composed since the surface is solid, non-porous, and homogeneous. This important property of clad metals has led to their widespread use in the chemical processing industries.

CLAD METAL CLASSIFICATIONS

Clad metal combinations are classified into four major categories: non-precious metal cladded to non-precious, precious metal cladded to non-precious, precious metal cladded to precious, and thermostat metals.

Some of the more common examples in these categories are—non-precious to non-precious: phosphor bronze-on-copper, stainless steel-on-copper, brass-on-steel, copper-on-beryllium copper, copper-on-steel, nickel-on-steel. Precious to non-precious: silver-on-beryllium copper, silver-on-copper, gold-on-copper, gold-on-nickel, silver-on-monel, silver-on-phosphor bronze, silver-on-steel. Precious to precious: palladium-on-silver, platinum-on-silver.

Various combinations of such metals as titanium, zirconium, and beryllium are being studied.

REASONS FOR USING CLAD METALS

Clad metals are used for these basic reasons: to supply an unusual physical property requirement, to fill an economic need, and to meet the demands of miniaturization.

Unusual physical properties—Clad metals supply a unique combination of properties in one unit. Clad metal parts are designed to take advantage of the most desirable properties of several metals. Corrosion-resistance with greater strength, corrosion-resistance with excellent thermal conductivity, oxidation resistance with thermostatic properties, or excellent bearing properties with high strength are properties which can be obtained.

A potential use of these new materials is found where the design requirements call for a set of properties that are not available in any one metal. This is shown by a current-carrying spring. High tensile strength, ability to withstand continuous flexure, surface hardness, high electrical conductivity, and ability to resist electric arcing are the requirements. This combination of properties cannot be found in any one metal but silver clad phosphor bronze, or silver clad beryllium copper will meet the requirement.

There are many other situations where it is impossible for any single metal to do the job adequately. A specific example of situations of this type are in the design of such items as circuit breakers, electric irons, or automatic chokes—units which must be actuated as a result of temperature changes. This problem can be solved by using a combination of two metals with different expansion characteristics, causing a deflection to take place as temperature rises.

One thermostat bimetal is composed of layers of equal thickness of Invar (36 per cent nickel-iron alloy) as the low-expansive lamina, and a nickel-chromium-iron alloy for the high-expansive component (nominal composition: 22% nickel, 3% chromium, the remainder iron). This general purpose bimetal combines a high deflection rate over a high temperature range with high strength, high electrical resistivity, and a fair degree of corrosion resistance.

Thermostat metals are available in a wide variety of shapes and forms—cantilver strips, U-shapes, spirals, helics, and flat blades.

Cost savings—A chemical container needs corrosion resistance plus surface wearing qualities and nickel is specified. Nickel is costly and in short supply and investigation shows that nickel clad steel can be used. In this case an extremely thin layer of the nickel will meet all of the engineering requirements and the use of steel will reduce costs.

Nickel-on-steel will solve the same problem in the electronic industry where, in the manufacture of cathode ray tubes, nickel is needed only as a surface element. Other examples of savings in costs effected by clad metals are found in the chemical and electrical industries. When specifications called for a material with good heat or electrical-conductivity properties, copper was formerly used. This can be replaced by less-expensive copper clad steel.

Cost-savings through the use of clad metals is most important in the chemical industry where precious metals, such as gold and platinum, are required to meet corrosion resistance problems. The substitution of clad metals for the solid metals—platinum-on-copper for solid platinum and gold-on-copper (gold-filled) for solid gold effects significant dollar savings.

SPECIFYING CLAD METALS

The type of cladding should be specified for metals can be cladded to each other in several ways. The nature of the cladding can help to solve the mechanical aspects of the design and contribute to meeting the economic requirements. Clad metal strip is commercially available in the following forms:

Overlay—a cladding on either one or both sides of a base metal in which the cladding extends the full width of the base metal.

Inlay—a cladding on either one or both sides of a base metal in which the cladding extends for only a portion of the width of the base metal.

Edgelay—a cladding on either one edge or the other of a base metal in which the cladding extends only a portion of the overall width and in the same thickness as the base metal.

Thrulay—a cladding which extends only a portion of the overall width and in the same thickness as the base metal, and which extends through the body of the composite.

Thickness and width should be specified. Manufacturers can now supply overlay in thicknesses down to 0.00001 in. and total overall thicknesses down to 0.0001 in. Widths are available to 4 in.

DESIGN FUNCTIONS OF CLAD METALS

The number of metals that can be clad to each other to produce new combinations of properties is increasing. Clad metals can usually be made to meet a particular set of specifications. There are, however, many standard composites which are available. Table I lists the more important clad metals and a description of their design functions.

SOME COMPARISONS BETWEEN CLAD AND ELECTROPLATED METALS

It is sometimes more economical to use clad metals rather than electroplated metals because the perfect bond between clad metal layers eliminates rejects of fabricated parts due to cracks and peeling caused by faulty electroplate. The clad metal overlay will not peel off during heat treatment, soldering, or during any other processing.

TYPES OF CLADDING, 1: Overlay; 2: Inlay; 3: Edgelay; 4: Thrulay.

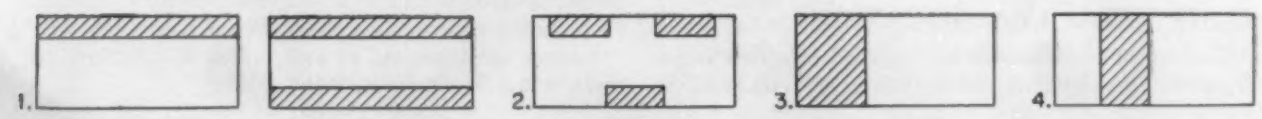


Table I

CLAD METALS	DESIGN FUNCTIONS	APPLICATIONS
Stainless Steel-on-Low Carbon Steel	Erosion-resistance Corrosion-resistance Base metal can be worked easily Decoration Base metal is low-cost ,	Decorative trim Cooking utensils Process industries equipment Hospital sterilizers Food display cases
Stainless Steel-on-Copper	Corrosion-resistance Erosion-resistance Thermal conductivity Uniform heat transfer Decoration Workable base, metal	Heat exchangers for chemical industry Pots and pans
Copper-on-Low Carbon Steel	Thermal conductivity Resistance to atmospheric gases Surface compressibility Excellent solder characteristics Strong, inexpensive base	Electrical contact points Electrical switches Immersion heater base plates
Phosphor Bronze-on-Copper	Excellent spring properties Base has high electrical conductivity	Current carrying springs Flat spring blades for switches and electrical meters
Nickel-on-Low Carbon Steel	Resistance to atmospheric gases Decoration	Broiler trays Fan blades Brush ferrules Toys Typewriter key levers
Monel-on-Low Carbon Steel	Corrosion-resistance Erosion-resistance Uniform heat transfer Low-cost base metal	Equipment for chemical and other process industries
Stainless Steel-on-Invar	Thermostat metals	Thermostats Circuit breakers
Silver-on-Copper	Oxidation-resistance at high temperatures Atmosphere resistance Electrical conductivity Low-cost base	Coils (high temperature) Conductors (high frequency) Radar cable braiding
Silver-on-Phosphor Bronze	Electrical contact properties Electrical conductivity Good spring properties in base	Electrical contact springs
Silver-on Beryllium Copper	Electrical contact properties Electrical conductivity	Current carrying springs
Copper-on Berryllium Copper	Good spring properties in base Good fatigue resistance in base	
Silver-on Nickel	Good wear-resistance Corrosion-resistance Electrical contact properties	Electrical contacts where corrosion-resistance and wear-resistance are important
Gold-on-Copper	Chemical-resistance Low-cost base	Chemical processing equipment
Gold-on-Nickel Gold-on-Brass	Chemical-resistance Low-cost base	Chemical processing equipment. Jewelry Wrist bands, watch cases

The perfect mechanical bond between clad metal layers insures excellent thermal and electrical conductivity whereas this may not always be so with electroplated metals. The clad metal overlay is hard, uniform, and dense because of the working given to the metal while an electroplate deposit is sometimes soft, non-uniform, and porous. A thin overlay offers greater resistance to corrosion, arcing, and pitting than a heavier electroplate deposit. Clad metal overlay thickness can be accurately predetermined. This is not possible with an electroplate.

A specific design problem may be solved by a coating on just one side of a fabricated part; electroplating, necessarily involves plating all sides.

The temper and other physical properties of clad metals can usually be provided to meet the specifications required.

LIMITATIONS TO USE OF CLAD METALS

All clad metals have limitations as to operating temperatures. If a bonding agent is used to produce the clad metal, the melting point of the bonding material must be

above the operating temperature of the clad metal. Otherwise, trouble might result with cracks or blistering in the operation.

The annealing temperatures of the respective layers of metals to be clad must be compatible with the melting point of the bonding material. This is necessary since the clad strip must be re-rolled and annealed periodically before it arrives at the finish thickness. If the annealing temperature of the clad metal combination is higher than the melting point of the bonding material, there will be production difficulties.

The metals to be clad must be examined from the point of view of electrolytic corrosion when they are in intimate contact with each other. Metals at opposite ends of the electromotive series could give trouble. This is sometimes overcome by the use of an interliner which would be compatible to both layers of metal and act as an galvanic insulator.

In some cases there are mechanical problems in the ability of a clad metal to take a deep draw. Each case must be examined on its own merits, since other variables would be the tooling and drawing techniques.

If a part must have its edges cladded, a clad metal would be ruled out in favor of electroplated metal where the overlay could be deposited on all sides of the metal.

CLAD METALS APPLICATIONS

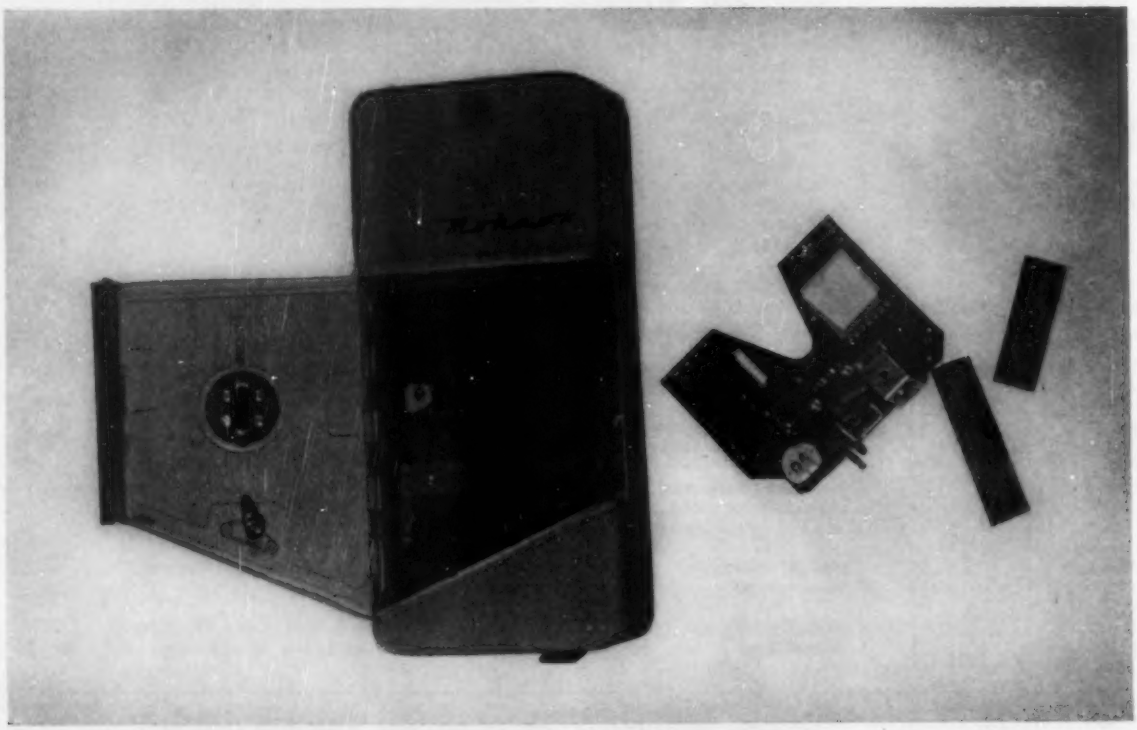
Currently clad metals are specified in the chemical, brewing, pulp and paper, textile, soap, food processing, automotive, hydraulic, petroleum, and electrical industries.

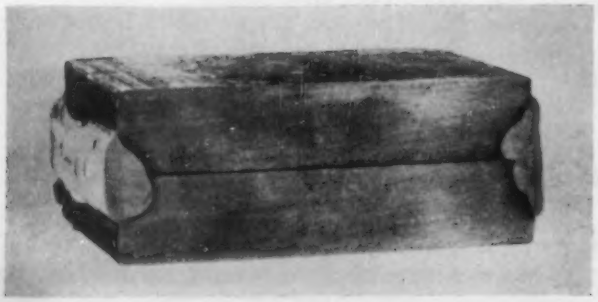
Clad metals are also being used for such thermal applications as heat exchangers, preheaters, tanks and tank cars, dryers, stills, autoclaves, coagulators, saturators, extractors, disinfectors, cookers, ovens, and kettles. They are used in evaporators, vats, crystalizers, mixers, and table tops.

More applications are found in cooking utensils, automotive bumpers, coins, badges, medallions, moldings, and stair nosings. Also: electric motor parts, ball bearing separators, gas meters, flexible and lock seam tubing, X-ray, automotive engine parts, immersion heaters, electronic equipment, and gaskets.

EDITOR'S NOTE—The use of composite materials is becoming increasingly important whether the cladding be rolled on, bonded or plated.

These are not essentially new materials but as the range of applications grows, new combinations and techniques are being developed. Clad metals are part of the story—electrodeposition is another part. The new developments in electroplating will be covered in an article which will appear in an early issue of *Product Engineering*.





SILVER CLAD phosphor bronze used as a current-carrying spring in a miniaturized tape recorder. Compactness, resistance to wear and electric arcing are the properties specified.

THERMOSTAT metals are bonded by hot-rolling with no material between them. The edges are welded before rolling and scalped when processing is complete.

Shock Isolation

Method of analyzing displacement and inertia loads of an elastically mounted structure under impact. Vibration mounts, designed for steady-state conditions, do not necessarily protect the product from impact loads because of the time constants of the system. Analysis is based on a half-sine-wave pulse but is non-dimensional so that it can be applied to any system controlled by the same parameters.

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SYMBOLS

m = mass
k = spring constant
c = damping coefficient
$c_c = 2\sqrt{mk}$ — critical damping coefficient
$\zeta = c/c_c$ — damping factor
ω_n = undamped natural frequency
$\omega_d = \omega_n\sqrt{1-\zeta^2}$ — damped natural frequency
T_n = period of undamped mass

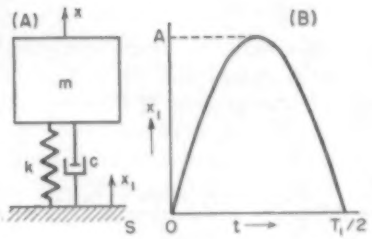


Fig. 1—Flexibly-mounted mass subjected to shock by sudden displacement of supporting structure *S*. Displacement and acceleration equations are derived in text for a half-sine-wave movement of supporting structure. Illustrated in (B).

IN VIBRATION ISOLATION studies the objective is to reduce the amplitude of the force transmitted from an isolated machine to a base or foundation on which the machine is mounted. Or, if the base is vibrating, it is to limit the amplitude of vibration excited in the machine by the base motion. In either case, the main consideration is the steady-state operating condition.

In shock isolation studies, however, the designer is concerned with the effects of suddenly applied forces or of sudden movements of the base. His objective is to reduce impact loads transmitted to the base, or to limit to a safe level the number of "g's" of acceleration to which the machine is subjected. In contrast to vibration isolation, the main consideration is the transient state of motion.

Fig. 1(A) shows a mass m, which may be a machine or instrument on a mount having spring stiffness k and viscous damping coefficient c. The displacement of the base at any instant is given by x_1. Fig. 1(B) shows a half-sine-wave pulse movement of the base, which occurs from the rest position of the system. The time duration of the pulse is $T_1/2$, where $T_1 = 2\pi/\omega$. The resultant displacement of m is given by x, its acceleration by d^2x/dt^2.

EQUATIONS OF MOTION

Considering m as a free body, and taking the sum of forces in the vertical direction, the equation of motion is

$$k(x_1 - x) + c\left(\frac{dx_1}{dt} - \frac{dx}{dt}\right) = m\frac{d^2x}{dt^2} \tag{1}$$

Collecting x terms on the left and x_1 terms on the right, Eq (1) becomes

$$m\frac{d^2x}{dt^2} + c\frac{dx}{dt} + kx = c\frac{dx_1}{dt} + kx_1 \tag{2}$$

Eq. (2) is valid for any type of motion of the base. For the half-sine-wave pulse, $x_1 = A \sin \omega t$, Eq (2) becomes

$$m\frac{d^2x}{dt^2} + c\frac{dx}{dt} + kx = c\omega A \cos \omega t + kA \sin \omega t \tag{3}$$

The solution to Eq (3) when $c < c_c$ is

$$x = (A_1 \sin \omega_d t + A_2 \cos \omega_d t)e^{-\frac{ct}{2m}} + f(t) \tag{4}$$

Values of A_1, A_2 and $f(t)$ for a system starting from rest have been derived in a previous article (see *Product Engineering*, April 1955, pages 150-155). In particular, the values in Table IV of the previous article for $F(t) = a_1 \cos \omega t$ and $b_1 \sin \omega t$ apply directly. Comparing these equations with Eq (3) above, it can be seen that $a_1 = c\,\omega\,A$ and $b_1 = kA$. Since the principle of superposition applies, the expressions

$$\frac{x}{A} = \frac{1}{(1-R^2)^2+(2\zeta R)^2}\left(\left\{\frac{R}{\sqrt{1-\zeta^2}}\left[R^2(1-2\zeta^2)-1\right]\sin 2\pi\sqrt{1-\zeta^2}\,T + 2\zeta R^3\cos 2\pi\sqrt{1-\zeta^2}\,T\right\}e^{-2\pi\zeta T} + \left[1-R^2(1-4\zeta^2)\right]\sin 2\pi RT - 2\zeta R^3\cos 2\pi RT\right) \quad (11)$$

$$\frac{T_n v}{A} = \frac{2\pi R}{(1-R^2)^2+(2\zeta R)^2}\left(\left\{\frac{\left[R^2(4\zeta^2-3)+1\right]}{\sqrt{1-\zeta^2}}\sin 2\pi\sqrt{1-\zeta^2}\,T + \left[R^2(1-4\zeta^2)-1\right]\cos 2\pi\sqrt{1-\zeta^2}\,T\right\}e^{-2\pi\zeta T} + \left[1-R^2(1-4\zeta^2)\right]\cos 2\pi RT + 2\zeta R^3\sin 2\pi RT\right) \quad (13)$$

$$\frac{T_n^2 a}{A} = \frac{4\pi^2 R}{(1-R^2)^2+(2\zeta R)^2}\left(\left\{\frac{R^2\left[8\zeta^2(1-\zeta^2)-1\right]+(1-2\zeta^2)\sin 2\pi\sqrt{1-\zeta^2}\,T}{\sqrt{1-\zeta^2}} + 2\zeta\left[1-2R^2(1-2\zeta^2)\right]\cos 2\pi\sqrt{1-\zeta^2}\,T\right\}e^{-2\pi\zeta T} - R\left[1-R^2(1-4\zeta^2)\right]\sin 2\pi RT + 2\zeta R^4\cos 2\pi RT\right) \quad (15)$$

$$\frac{x}{A} = \left(\frac{T_n\left[v_1/A\right]-2\pi\zeta\left[x_1/A\right]}{2\pi\sqrt{1-\zeta^2}}\sin 2\pi\sqrt{1-\zeta^2}\,T_c + \frac{x_1}{A}\cos 2\pi\sqrt{1-\zeta^2}\,T_c\right)e^{-2\pi\zeta T_c} \quad (17)$$

$$\frac{T_n v}{A} = \left(-\frac{\zeta T_n\left[v_1/A\right]+2\pi\left[x_1/A\right]}{\sqrt{1-\zeta^2}}\sin 2\pi\sqrt{1-\zeta^2}\,T_c + \frac{T_n v_1}{A}\cos 2\pi\sqrt{1-\zeta^2}\,T_c\right)e^{-2\pi\zeta T_c} \quad (18)$$

$$\frac{T_n^2 a}{A} = 2\pi\left(\frac{-(1-2\zeta^2)T_n\left[v_1/A\right]+2\pi\zeta\left[x_1/A\right]}{\sqrt{1-\zeta^2}}\sin 2\pi\sqrt{1-\zeta^2}\,T_c - 2\left[\zeta T_n\left[v_1/A\right]+\pi\left[x_1/A\right]\right]\cos 2\pi\sqrt{1-\zeta^2}\,T_c\right)e^{-2\pi\zeta T_c} \quad (19)$$

where $[x_1/A]$ = nondimensional displacement of m at end of pulse period

$T_n[v_1/A]$ = nondimensional velocity of m at end of pulse period

given in the earlier article are added to give the following formulas for A_1, A_2 and $f(t)$:

$$\frac{A_1}{A} = \frac{k\omega\left(\frac{c^2}{2m}+m\omega^2-k\right)-c^2\omega\left(\frac{k-m\omega^2}{2m}+\omega^2\right)}{\omega_d[(k-m\omega^2)^2+(c\omega)^2]} \quad (5)$$

$$\frac{A_2}{A} = \frac{kc\omega-c\omega(k-m\omega^2)}{(k-m\omega^2)^2+(c\omega)^2} \quad (6)$$

$$\frac{f(t)}{A} = \frac{[k(k-m\omega^2)+(c\omega)^2]\sin\omega t+[c\omega(k-m\omega^2)-ck\omega]\cos\omega t}{(k-m\omega^2)^2+(c\omega)^2} \quad (7)$$

NONDIMENSIONAL EQUATIONS

The above equations can be rewritten in terms of non dimensional parameters by dividing numerator and denominator of each right hand expression by k^2 and making the following substitutions:

$$k/m = \omega_n^2$$
$$\omega/\omega_n = T_n/T_1 = R$$
$$c\omega/k = 2\zeta R$$
$$c/(2m) = \zeta\omega_n$$
$$\omega_d = \omega_n\sqrt{1-\zeta^2}$$
$$T_n = 2\pi/\omega_n$$
$$T \text{ (nondimensional time)} = t/T_n$$
$$\omega_n t = 2\pi T$$
$$\omega_d t = 2\pi\sqrt{1-\zeta^2}\,T$$
$$\omega t = 2\pi RT$$

Thus, time is measured in terms of the period T_n of the free undamped vibration of the isolated mass, damping expressed as a fraction of critical damping, and the period of free undamped vibration taken as a ratio R with respect to twice the time duration of the pulse.

Eqs (5), (6) and (7) now become

$$\frac{A_1}{A} = \frac{R[R^2(1-2\zeta^2)-1]}{\sqrt{1-\zeta^2}[(1-R^2)^2+(2\zeta R)^2]} \quad (8)$$

$$\frac{A_2}{A} = \frac{2\zeta R^3}{(1-R^2)^2+(2\zeta R)^2} \quad (9)$$

$$\frac{f(t)}{A} = \frac{[1-R^2(1-4\zeta^2)]\sin 2\pi RT - 2\zeta R^3\cos 2\pi RT}{(1-R^2)^2+(2\zeta R)^2} \quad (10)$$

The nondimensional displacement response of the isolated mass during the half sine-wave pulse motion of the base is given by Eq (11) which appears in the box above.

The velocity v of the isolated mass is dx/dt. Since $T = t/T_n$, then $dT = dt/T_n$ and

$$\frac{T_n v}{A} = \frac{d(x/A)}{dT} \quad (12)$$

where $T_n v/A$ is a nondimensional velocity given by the ratio of the actual velocity to the average velocity developed in moving distance A in time T_n. Since T_n and A are both definite quantities in the problem, the velocity A/T_n is a suitable reference for nondimensionalizing the velocity.

The velocity of m during the action of the base pulse is given by Eq (13), also listed above.

The acceleration of the isolated mass is $a = dv/dt = T_n dv/dT$. By substituting from Eq (12), the nondimensional expression for acceleration is

$$\frac{T_n^2 a}{A} = \frac{d(T_n v/A)}{dT} \quad (14)$$

In Eq (14) the reference acceleration, A/T_n^2, is one-half the value of the constant acceleration which would move m from rest through the distance A in time T_n.

The acceleration of m during the action of the base pulse can be expressed as Eq (15) on page 168.

The acceleration a_b of the base in terms of the same reference acceleration is

$$\frac{T_n^2 a}{A} = -4\pi^2 R \sin 2\pi RT \tag{16}$$

The ratio of Eqs (15) and (16) gives the effectiveness of the flexible mounting in reducing the transmission of acceleration from base to mass during the pulse action.

MOTION AFTER PULSE STOPS

To evaluate the continuing motion of m after the pulse stops, it is convenient to start measuring time from zero at $T = T_1/2$. This introduces a new variable T_c, where $T_c = T - T_1/2$. The free motion is then given by the nondimensional equations, Eqs (17), (18), and (19) which are grouped on page 168.

CRITICAL DAMPING

For critical damping, $c = c_c$, or $\zeta = 1$, the solution to Eq (3) is

$$x = (A_1 + A_2 t)e^{-\omega_n t} + f(t) \tag{20}$$

Expressions for A_1, A_2 and $f(t)$ under the excitation given in Eq (3) are found from Table V of the referenced article. By superposition and by conversion to nondimensional form, these expressions become

$$\frac{A_1}{A} = \frac{2R^3}{(1 - R^2)^2 + 4R^2} \tag{21}$$

$$\frac{T_n A_2}{2\pi A} = -\frac{R(R^2 + 1)}{(1 - R^2)^2 + 4R^2} \tag{22}$$

$$\frac{f(t)}{A} = \frac{(1 + 3R^2)\sin 2\pi RT - 2R^3 \cos 2\pi RT}{(1 - R^2)^2 + 4R^2} \tag{23}$$

The displacement, velocity and acceleration of m during the pulse are given by Eqs (24), (25), and (26) at the bottom of this page. The equations of motion after the pulse ends are Eqs (27), (28), and (29).

EXAMPLES

Nondimensional response curves are shown in Fig. 2 for undamped systems ($\zeta = 0$) for various durations of a half-sine-wave pulse from 1/20 of a natural period to twice this period ($R = 10$ to $R = \frac{1}{2}$). These curves show that a short duration impulse results in a small displacement and that long durations also result in small displacements. Larger displacements occur when the pulse time approximates the natural period.

The largest response in the positive direction is seen to occur when the pulse duration equals the natural period ($R = 1$), while the largest response in the negative direction occurs when the pulse duration equals one-half the natural period ($R = 1$). For an impulse lasting 1.5 periods ($R = \frac{1}{3}$), the undamped mass comes to rest upon cessation of the impulse.

To study the effect of damping on the motion of the pulsed mass the fast pulse ($R = 10$) was chosen for calculation. Equivalent curves for any other pulse time can be calculated readily from the formulas given in this article. The calculated curves for displacement are shown in Fig. 3 at an enlarged vertical scale as compared with Fig. 2. In this instance, small amounts of damping increase the maximum displacement in the early stages of the motion, a minimum occurring at about 20 per cent of critical damping. With more damping, the peak displacement in the early motion of the mass increases again and after about 50 per cent of critical it exceeds the undamped peak. The later motion, however, dies out rapidly. It should be borne in mind that the detailed effects described apply only to the particular case of $R = 10$. For other values of R the curves will shift.

Accelerations for the undamped and damped conditions are shown in Fig. 4(A), undamped accel-

$$\frac{x}{A} = \frac{\left[2R^3 - R(R^2+1)\,2\pi T\right] e^{-2\pi T} + (1+3R^2)\sin 2\pi RT - 2R^3\cos 2\pi RT}{(1-R^2)^2 + 4R^2} \tag{24}$$

$$\frac{T_n v}{A} = \frac{2\pi R}{(1-R^2)^2+4R^2}\left(\left[2\pi(R^2+1)T - 3R^2 - 1\right]e^{-2\pi T} + (1+3R^2)\cos 2\pi RT + 2R^3 \sin 2\pi RT\right) \tag{25}$$

$$\frac{T_n^2 a}{A} = \frac{4\pi^2 R}{(1-R^2)^2+4R^2}\left(2\left[-\pi(R^2+1)T + 2R^2 + 1\right]e^{-2\pi T} - R(1+3R^2)\sin 2\pi RT + 2R^4\cos 2\pi RT\right) \tag{26}$$

$$\frac{x}{A} = \left(\frac{x_1}{A} + \left[\frac{x_1}{A} + \frac{T_n v_1}{2\pi A}\right] 2\pi T_c\right) e^{-2\pi T_c} \tag{27}$$

$$\frac{T_n v}{A} = 2\pi\left(-\frac{x_1}{A} + \left[\frac{x_1}{A} + \frac{T_n v_1}{2\pi A}\right](1 - 2\pi T_c)\right) e^{-2\pi T_c} \tag{28}$$

$$\frac{T_n^2 a}{A} = 4\pi^2\left(\frac{x_1}{A} - 2\left[\frac{x_1}{A} + \frac{T_n v_1}{2\pi A}\right](1 - \pi T_c)\right) e^{-2\pi T_c} \tag{29}$$

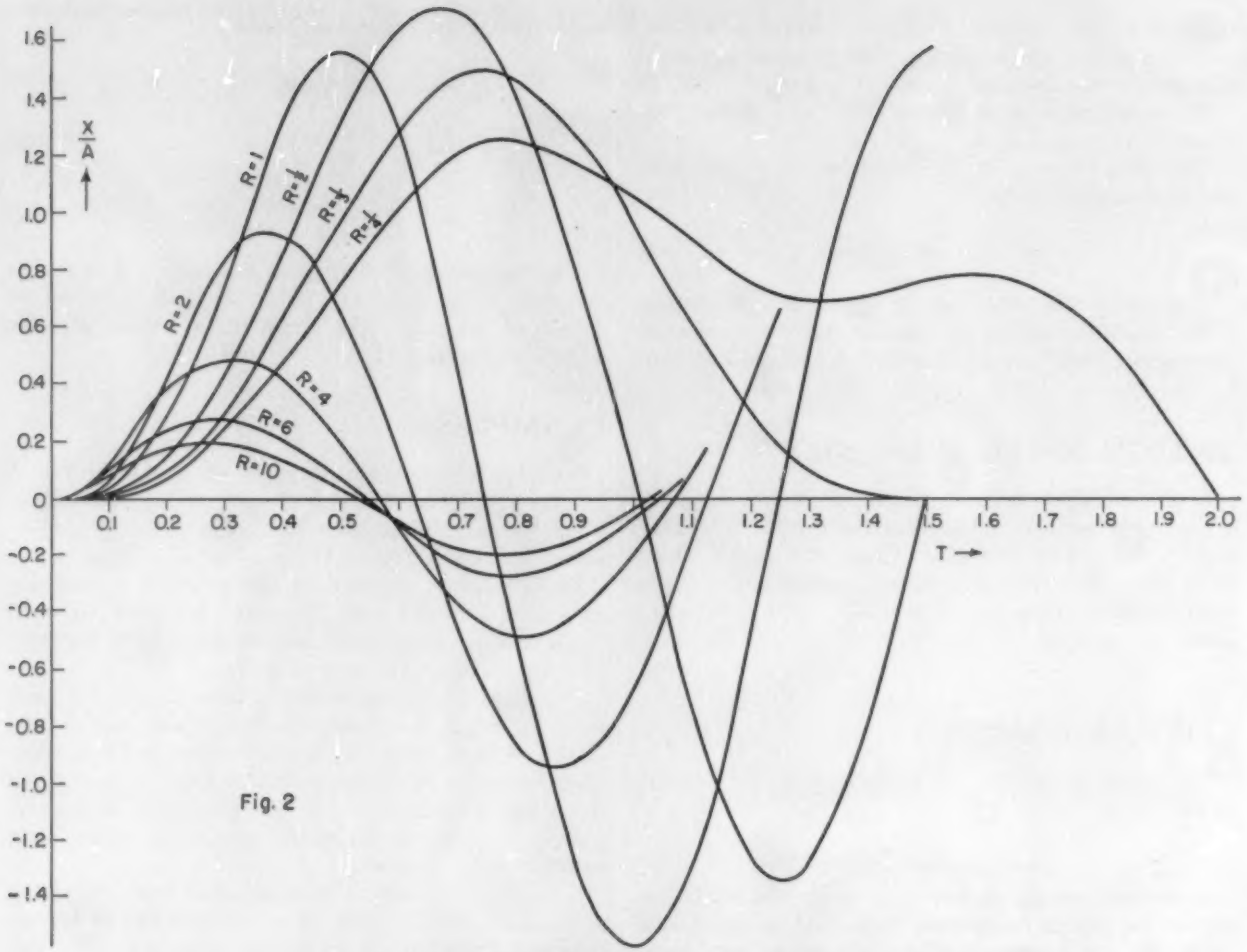


Fig. 2—Nondimensional displacement of supported mass resulting from half-sine wave pulse movement of supporting structure. Decreasing values of R indicate increasing time-durations of pulse. No damping.

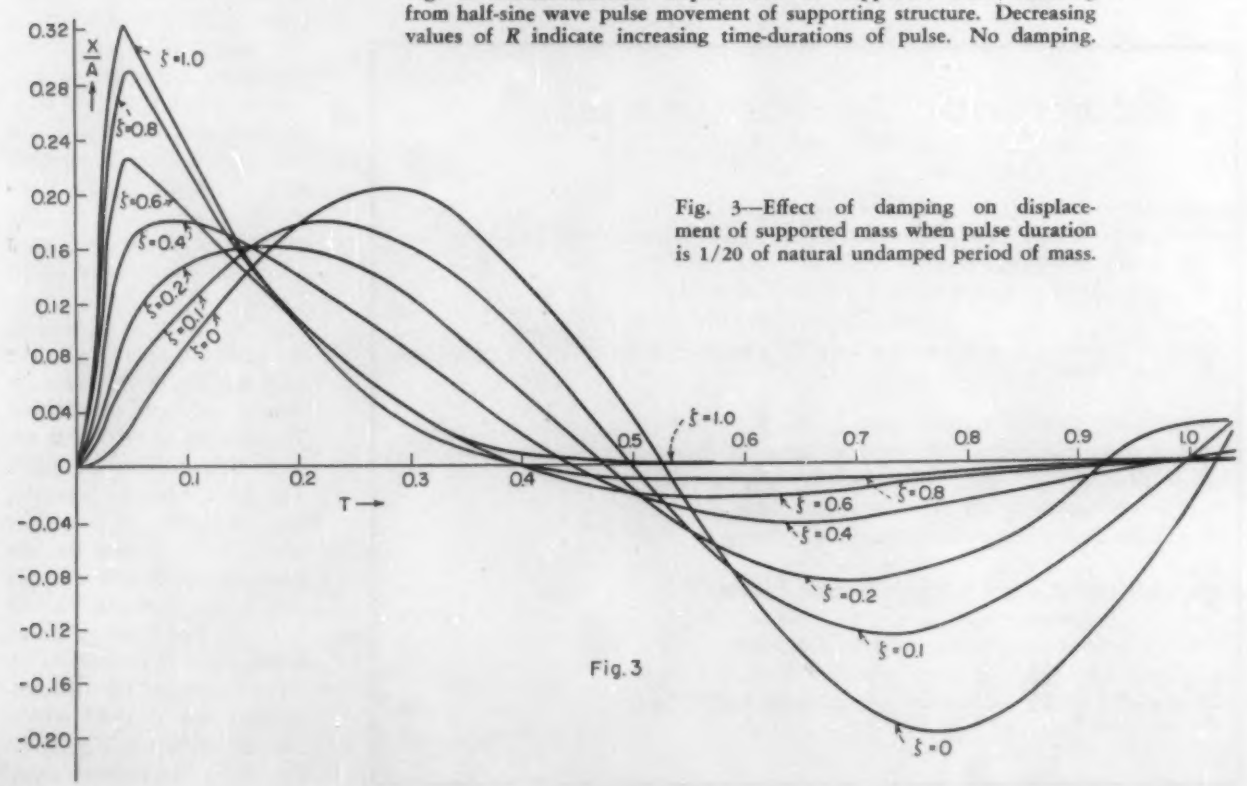


Fig. 3—Effect of damping on displacement of supported mass when pulse duration is 1/20 of natural undamped period of mass.

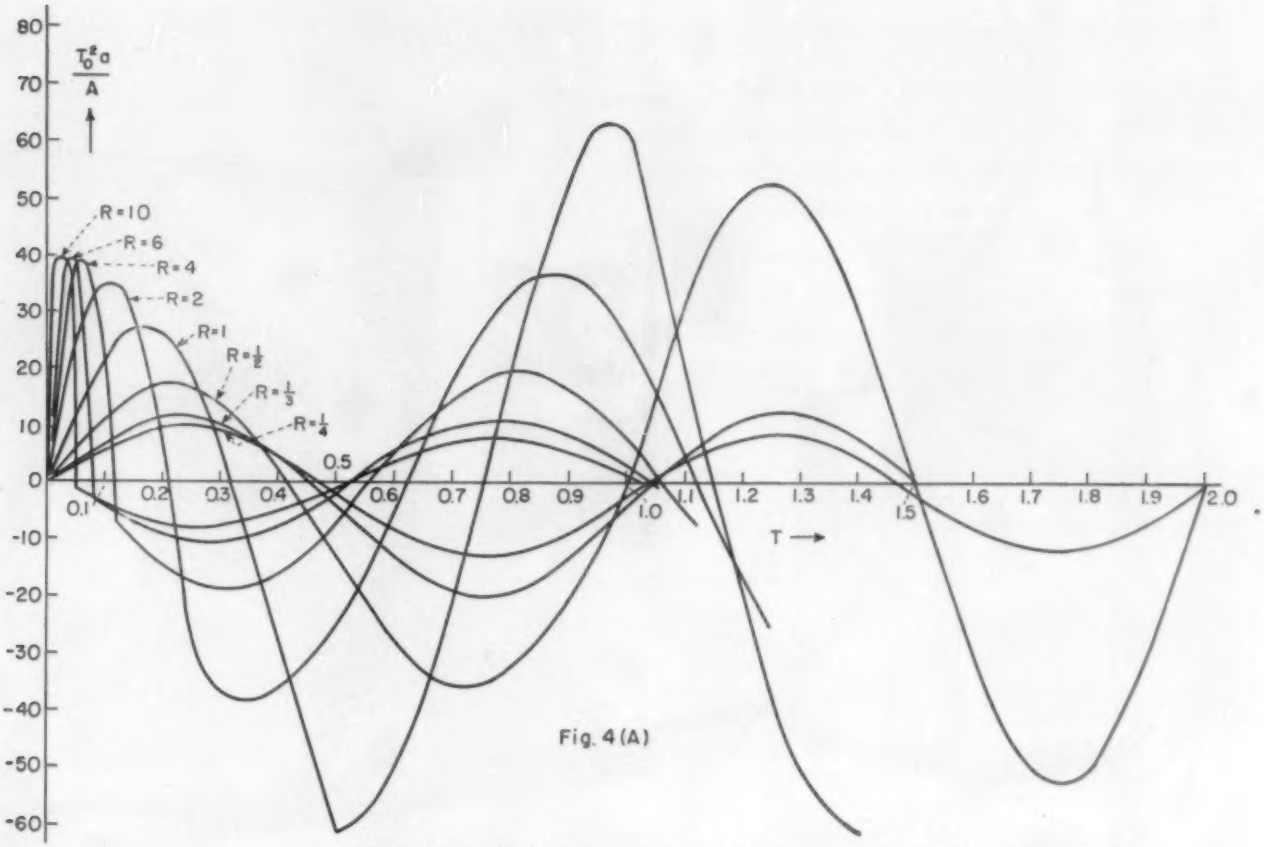
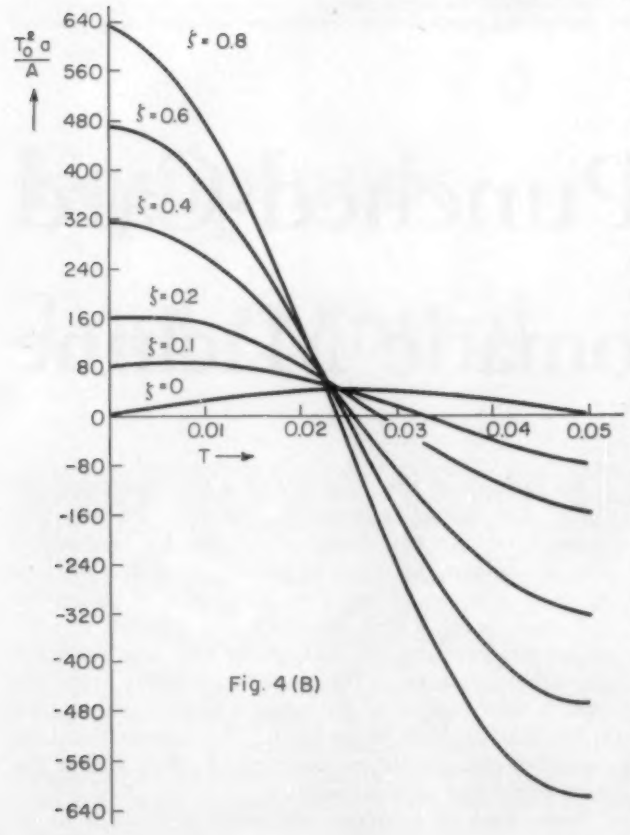


Fig. 4—Nondimensional acceleration of supported mass, (A), resulting from half-sine-wave pulse movement of supporting structure. In (B) is shown the effect of damping on acceleration of supported mass when pulse duration is 1/20 of natural undampened period of mass. The value of R is ten.



erations during action of the pulse increase with R. In the later motion, however, maximum acceleration occurs for $R = 1$, (pulse time = ½ natural period), and the peak falls off for increasing and decreasing values of R.

With damping present, accelerations increase rapidly as damping increases. These effects are shown in Fig. 4(*B*) for the fast pulse ($R = 10$). Accelerations are plotted only for the interval during which the pulse acts ($T = 0$ to $T = 0.05$), since the accelerations occurring after cessation of the pulse are comparatively small in the presence of damping.

EDITOR'S NOTE—The derivations and calculations in this article are based on a half-sine-wave motion of the base. In practice, pulses can assume many forms. Data for treating those which can be represented by a power series, trigonometric series, exponentials or any linear combination of such terms, were included in the previous article by Professor Soroka, in *Product Engineering*, April 1954.

Two other recent articles dealing with subject of shock loading which contain useful supplementary information are:

1. "Damping Capacity of Materials," Alexander Yorgiadis, *Product Engineering*, November 1954, pages 164-170.
2. "Effects of Shock Loading," W. M. Murray, *Product Engineering*, December 1954, pages 171-175.

In the first reference, a practical approach is developed for analyzing and evaluating the damping capacity of various materials in nonuniformly as well as uniformly stressed members. In the second, Mr. Murray shows the effect of various types of pulse-loadings on a beam structure.

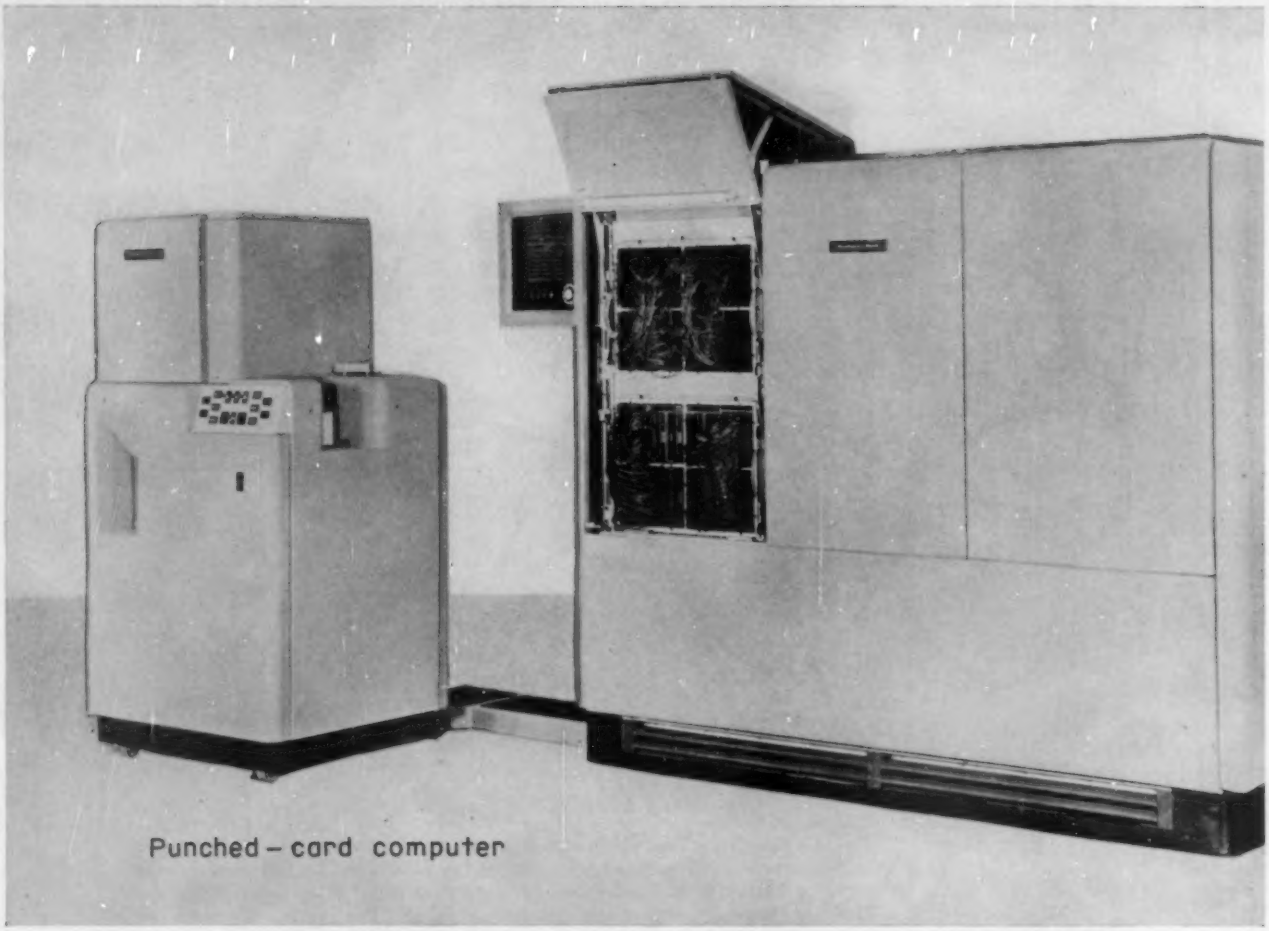


Fig. 1—Punched-card computer and card-to-tape converter used for performing punched-card calculations and converting punched

Using Punched-Card For Automatic Machine

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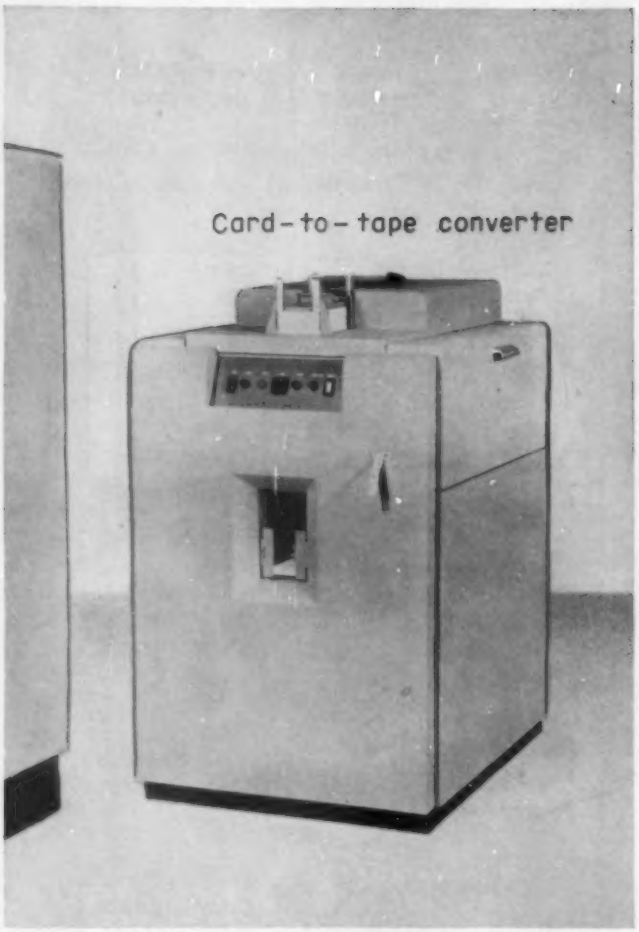
THE PRESENT TREND toward automation in industry has resulted in the development of automatic machine tools capable of producing manufactured parts of extremely complex shapes, accurate to fine tolerances. Tape-controlled automatic tools have been developed to handle production too limited and operations too complex to be dealt with economically by automatic screw machines, tracer-controlled machines and the like. The preparation of the tapes to control these tools often involves complex and lengthy calculations on known design data.

An example of this is in use of a tape-controlled machine[1] for cutting non-circular gears—a Fellows gear shaper to which a tape-driven servo system has been added. The computation necessary to provide input data to these servos is involved. More than 100 hours of calculation and work, using a desk calculator, are required in computing and punching the data on the tape which controls the servomechanism. The machine, working from the tape, is then capable of producing a finished set of gears in less than an hour of operation. The computation time represents the greatest expenditure of effort and is the most costly part of the operation.

Some form of automatic computer is required to re-



card data to holes in tape which operates automatic machine tool.

Equipment Tool Control

Computation time required for calculating and transcribing data on tapes used to control automatic machine tools producing complex shapes is most costly part of operation. Use of punched-card calculators—common in business office—and card-to-tape converters provides economical solution.

duce these long periods of calculating time. In many cases, such as in the design of non-circular gears, precision cams, and other special generated surfaces, the use of a punched-card calculator, common in the business office, is the most economical solution. These punched-card equipments, shown in Fig. 1, are flexible and fast enough to handle many problems usually considered large-scale computer fare. Card-to-tape converter, shown in Fig. 1, readily transcribes this card data, suitable for operating automatic machine tools, directly on the tape.

A knowledge of punched-card computer operation is important to an understanding of the actual method of solution. This computer utilizes electronic methods to perform series of basic arithmetic operations. The values involved are sensed from punched cards, taken from storages where they were previously placed as results of prior operations or read from preset constant storages. The results of these operations are punched on the cards or held in storage for future calculation and punching.

The computer performs the operations of addition, subtraction, multiplication and division repetitively and in combination as required by a preset program it punches one or more of the results of these programmed operations on cards specified, at a maximum card-handling speed of 150 cards per minute. It can reproduce any or all alphabetical or numerical information punched on a card or cards, on all or on specific follow-cards either in combination with calculation or as an independent operation.

All information on the card may be read into the input unit and held there until it has been used for the desired calculation. Results obtained may be held in storage until punched. Twelve ten-digit computed results with their signs may be retained for punching. By special programming, more values of fewer digits may be stored satisfactorily. Any number of digits may be punched up to the limit of the card.

A 10-digit number may be added to, subtracted from, multiplied by, or divided by a 10-digit number to give a 10-digit result which can be stored in one of the 12 10-digit output storages. If it is necessary to use this storage over again to compute more punched results, it is possible to transfer the original information out of this output storage and into the punch actuators. In this manner, more storages are available for holding intermediate factors (results of computations which will in turn be used to compute punched results).

In the solution of a problem the computer executes a planned program consisting of a series of steps. During each step, two values are selected from input or storage, added, subtracted, multiplied, or divided as specified, and the result is placed in a desired location and checked by a reverse operation and the next program step or operation is selected.

The addition or subtraction of two 10 digit numbers is performed in 10 milliseconds. Multiplication and division require 50 milliseconds on the average, depending upon the specific digits contained in the values. The entire program is set up on plugboards which may be readily inserted and removed from the computer to facilitate handling of long problems. Each program plugboard provides for the setup of forty distinct arithmetical steps.

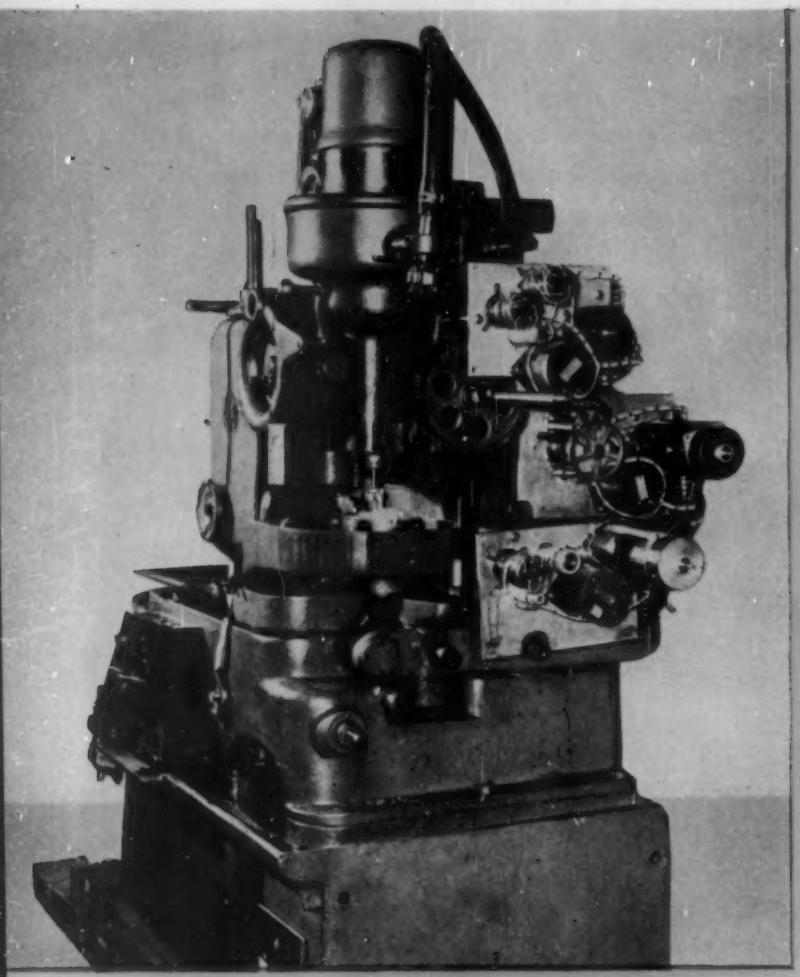


Fig. 2—Tape-controlled Cunningham gear cutter with covers removed to show servos actuated by impulses from tape. The machine is a Fellows gear shaper to which the servos have been added for cutting non-circular gears.

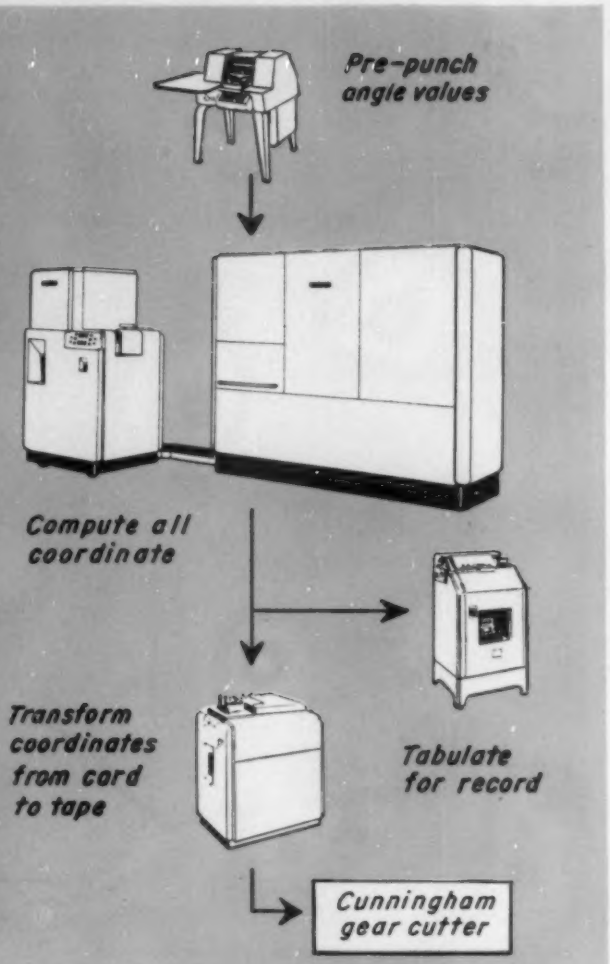


Fig. 3—Diagram of punched-card computing system for calculating gear-cutting machine coordinate data and transforming computed coordinates from punched card to punched tape. Tape is applied to operate gear cutter.

Because of the ability to select the next step, dependent on the algebraic sign of the result of the particular step, iteration may be provided. Iteration implies a circulatory re-use of steps until a desired change of sign of a particular storage signals a jump-out of the iteration routine. A more complete description of the philosophy of this computer may be found in recent publications.[2]

COMPUTATIONS FOR NONCIRCULAR-GEAR DESIGN

A practical application of the use of punched-card equipment is in the computations required for the design of a noncircular-gear. This gear is made from the gear cutter shown in Fig. 2. The complete computation system used to prepare the tape from punched cards is shown, from top to bottom, in Fig. 3.

Non-circular gears have been known and used to some extent for a great many years. They can be designed to generate almost any function that does not reverse its slope or have a discontinuity. The ratio of the velocity of the driven gear to that of the driver can vary by more than fifty to one as the driver rotates through one revolution. They have the usual properties of gears—high efficiency of power transmission and high accuracy—in contrast to cams, which usually have pressure-angle troubles and lost-motion errors in the follower system.

Non-circular gears have been considered by most machine designers to be mathematical curiosities rather than practical machine elements. The main reason for this is a lack of a source of supply for any but simple elliptical gears. It is not feasible to attempt to produce this type of gear without some kind of automatic control.

The problem of noncircular-gear design originates basically with data which gives angular displacement of one gear versus the angular displacement of the second or matched gear. At any instant, the ratio of angular velocities of the two gears are inversely proportional to their radii. From the table of angular values the velocity and radii

can be obtained by some form of approximation. It is convenient to perform the calculations first for a pair of gears having a unit center distance. These gears are nominally termed a θ, and a ϕ gear for explanatory purposes.

From the relationship of radii to angular velocity given above, the equation for the radius of the θ gear (r_θ) is found to be

$$r_\theta = \frac{1}{\frac{d\theta}{d\phi} + 1}$$

where $\frac{d\theta}{dt}$ equals the angular velocity of the θ gear, and $\frac{d\phi}{dt}$ is the corresponding angular velocity of the ϕ gear. Where ϕ is an analytical function of θ, the solution is usually simple, but in this case, where the function is expressed only in tabular form, the value of $d\theta/d\phi$ must be obtained by the use of numerical differentiation formulas employing finite differences.

Assuming a parabolic interpolation formula of the form $\phi = A+B\ (\theta-\theta_2) + C\ (\theta-\theta_2)^2$, values of r corresponding to specific θ and ϕ values may be obtained. The equation which must be solved is

$$r\theta_2 = \frac{(\phi_1-\phi_2)(\theta_2-\theta_3)^2-(\phi_3-\phi_2)(\theta_1-\theta_2)^2}{(\theta_1-\theta_2)(\theta_2-\theta_3)^2-(\theta_2-\theta_3)(\theta_1-\theta_2)^2+(\phi_1-\phi_2)(\theta_2-\theta_3)^2-(\phi_3-\phi_2)(\theta_1-\theta_2)}$$

By holding two previous values of θ and ϕ in storage and reading the third set from a specific card, the value of r_θ may be found from this equation and punched on the card. It is also possible from this data to determine the arc length of the gear from the starting point. This is determined by successive additions of successive increments. The calculation is necessarily an approximate one but so long as the same value of arc length (l) is used for each gear of a pair, the small errors will not accumulate. The approximation used is $(\Delta l)^2 = (\Delta r)^2 + r_2 r_3\ (\Delta\theta)^2$ and the value of $l_3 = l_2 + \Delta l$ and so on. When the gear is cut with a circular cutter it is also necessary to determine the angle, or some function of the angle, between the common tangent of the two gears, and the normal of the line of centers as shown in Fig. 4. The tangent of this angle is $dr/r\ d\theta$.

The equation is

$$\tan s = \frac{dr}{r\,d\theta} = \frac{2C}{B(1+B)}$$

where

$$C = \frac{(\theta_1-\theta_2)(\phi_2-\phi_3)-(\theta_2-\theta_3)(\phi_1-\phi_2)}{(\theta_1-\theta_2)(\theta_2-\theta_3)^2-(\theta_2-\theta_3)(\theta_1-\theta_2)^2}$$

and

$$B = \frac{(\phi_1-\phi_2)(\theta_2-\theta_3)^2-(\phi_2-\phi_3)(\theta_1-\theta_2)^2}{(\theta_1-\theta_2)(\theta_2-\theta_3)^2-(\theta_2-\theta_3)(\theta_1-\theta_2)^2}$$

This much of the calculation is then set up as a single program. The values of θ and ϕ given for the gears are punched on cards which are set up to receive output values of r, tan s and l (the arc length), as well as the previous value of θ and ϕ designated as θ_2 and ϕ_2 as compared with the input data which was labelled θ_3 and ϕ_3. This computation involves 51 program steps and eight constants set up on the board.

There are 16 single-pole relays and 20 four-pole relays available on the plugboard which permit changing of values used in steps already programmed and thus actually increase the number of program steps beyond the forty provided. These relays are activated after the original steps have been performed. All 12 storages are utilized and 30 digits on output are punched. This program has a running time on the calculator of six seconds per card. The

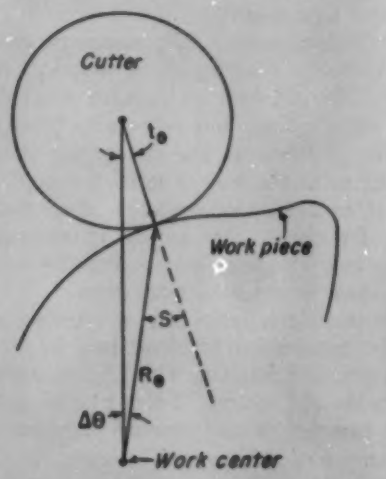


Fig. 4—Relation of circular gear cutter to noncircular gear. When gear is to be cut with circular cutter it is also necessary to determine the angle, or some function of the angle, between the common tangent of the two gears and the normal to the line of centers.

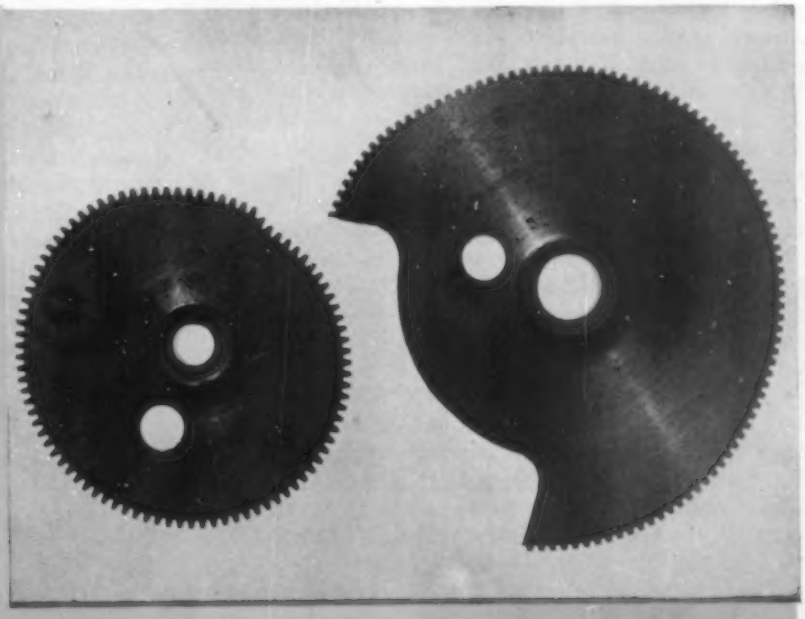


Fig. 5—Non-circular gears produced from punched-card computations converted to punched tape for automatic gear-cutting control.

cards are then used over again to be processed under the second program.

In the second program, actual gear-cutting data are computed. This requires certain trigonometric calculations in order to determine for each given point the distance between centers of the work piece and the cutter, and the angle through which each must be turned. Since the pair comprises two gears, six quantities must be recorded. For record purposes, it is also desirable to record the radii of the two gears. The equation to be programmed to find the center distance between work piece and cutter is

$$D_\theta = \sqrt{R_\theta^2 + r_c^2 + \frac{2R_\theta r_c}{\sqrt{1 + \tan^2 s}}}$$

where R_θ is the actual value of the radius of this gear (previous value r_θ, computed on basis of center distance of one, multiplied by actual center distance). D_ϕ is obtained from a similar equation where R_ϕ is equal to the center distance minus R_θ.

The equation for the angle thru which the work piece must be moved, G_θ, is

$$G_\theta = \theta_1 - \Delta\theta$$

where

$$\tan \Delta\theta = \frac{r_c \sin s}{R_\theta + r_c \cos s}$$

The equation for the angle of movement of cutter, H_θ, is:

where $H_\theta = (L_a/rc) - t_\theta$

L_a = arc length corrected for true center distance.

r_c = cutter radius

and $t_\theta = \tan^{-1} \dfrac{R_\theta \sin s}{r_c + R_\theta \cos s}$

A set of analogous equations gives values for G_ϕ and H_ϕ. The calculations are programmed in 64 steps and required 30 digits of input and 10 constants two of which are the radius of the cutter and the center of the cutter, previously defined as equal to l, but now compensated to be the true value. The output values are the six quantities previously mentioned plus the radii or eight quantities in all, representing 40 digits of output. With the iterations necessary to determine square root and arc tan, the program takes 14 seconds per card. The running of these two programs for any set of gear data is extremely simple and requires very little time. Results are the actual gear cutting data needed. These computations performed on the calculator represent a sizable saving in computation time in the order of a reduction from 50 hours of computation to a half hour of punched-card machine work.

In the actual execution of the gears it is necessary to rotate the work spindle and the cutter spindle at varying rates, and at the same time drive the cutter spindle toward or away from the work spindle. The method of doing this is to divide up each required motion into steps. The steps of work rotation are one minute of angle; the steps of cutter rotation are equivalent to 0.01 of a tooth which is 0.15 degrees on a 24-tooth cutter; and the steps of motion of the cutters center towards the work spindle are 0.00025 in.

The actual work of cutting the gear requires point-by-point movement of one of the three parameters a fixed number of their basic incremental steps. Since each card has a value of the specific angle through which each gear has been turned and the distance between centers, it is necessary to compute differences in these six quantities and then convert these differences to steps of the cutter spindle, work spindle and relative location of their centers.

Following each master card a group of blank cards are inserted and the whole file is then run through program 3. This program computes the number of steps of variation of the basic quantities involved for a given gear computed as fractional part of the largest number of these particular steps. The fractions and largest number of steps are recorded on the blank cards. The master card is sorted out during this run. Two runs of the type mentioned above are necessary to produce cards for both θ and ϕ gears, using master cards to operate proper selectors to pick up the correct data for each computation. Twelve constants are used.

The output consists of 18 digits of information. The first card following each master card is punched with a control hole to indicate that it is the first card in each group. This program is 27 steps long.

When these detail cards with the data are run through the fourth program, the end results represent, in the coded form required by the servo controlled gear shaper, the detail movement of each of the three controlling servos. On each card is punched forty digits in order, in a 1, 2, 4 code combination. The "1" represents one basic step change in center distance between work-piece and cutter, the "2" represents a basic step of rotation of the work-piece and the "4" represents a step of rotation of the cutter. The second card represents a continuation of this (another 40 steps). The punching continues until a number of digits has been punched equal to the largest number of steps recorded. This technique provides then for a smooth distribution between the data points furnished. The fourth run takes a total of two hours and a quarter. This is a rather slow computation but makes the total time for the entire four-program run approximately three hours. The completed calculations are then transcribed directly from the cards to teletype tape using a standard punched-card-to-tape converter. The gear cutting equipment reads this tape directly.

The complete system provides a fully automatic process for producing extremely complex parts directly from known input data. The tabulator is included to produce a printed record for checking and reference. From the moment the cards, punched at the key punch station, enter the computer until the pair of gears is completed, requires 4 hours if an overlap of operation is scheduled; while the values for the ϕ gear are being computed, the θ gear is being cut. The teletype tape may be re-used many times to produce more of the same gears.

With a flexible small computer and card-to-tape converter many similar automation problems may be solved in an inexpensive practical fashion. The field of application is extremely wide and the use of this type of system for automatizing complex manufacturing problems depends on the ingenuity of the systems designer.

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CABINET DESIGN
for complex equipment

Basic types of construction developed for electrical equipment are applicable to housings for mechanical components, too. How to obtain full access to equipment for test and maintenance with a minimum of required floor area, attractive appearance with simplicity and low cost, desired ventilation and safety; and some typical installations.

ROBERT H. TANNER
Assistant Superintendent of Development Engineering
Northern Electric Co. Ltd., Belleville, Ontario, Canada

THE GROWING SIZE and complexity of electrical and electronic equipment for a rapidly expanding field of applications has created a challenge on housing design to effect economies in space, weight, and cost, without sacrificing appearance. No longer can circuit wiring be random and enclosed in the nearest convenient metal box or wood cabinet.

TYPES OF CONSTRUCTION

Cabinet design must be predicated upon the cost bracket into which the equipment falls, the relative importance of appearance and accessibility, and whether the new equipment is related in any way to that already designed—such as proposed location adjacent to an existing installation, or a desired "family relationship" with earlier acceptable designs.

There are three basic types of construction to choose from:

(1) Rack construction.
  (a) Direct mounting.
  (b) Drawer mounting.
(2) "Walk-in" cabinet construction.
(3) Console cabinet construction.

Selection of type will depend on the average size of components, the size of the largest component, the method

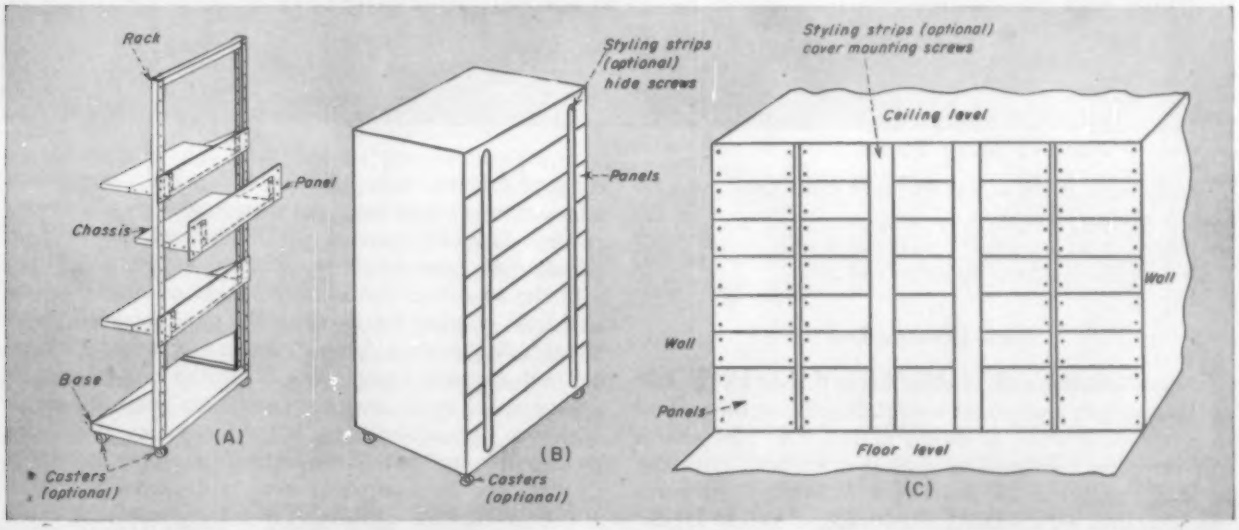


Fig. 1—Direct "relay-rack" method of mounting various units of a large or complex equipment. The chassis can be mounted either horizontally in the rack, as shown at (A), or vertically. To improve appearance, particularly where the equipment must be in an open area, the sides, back and top may be closed in as shown at (B). Another approach to improved appearance at low cost is to place the racks side by side extending from wall to wall and floor to ceiling as shown at (C). In such cases, space is often provided at the rear for access to wiring and components.

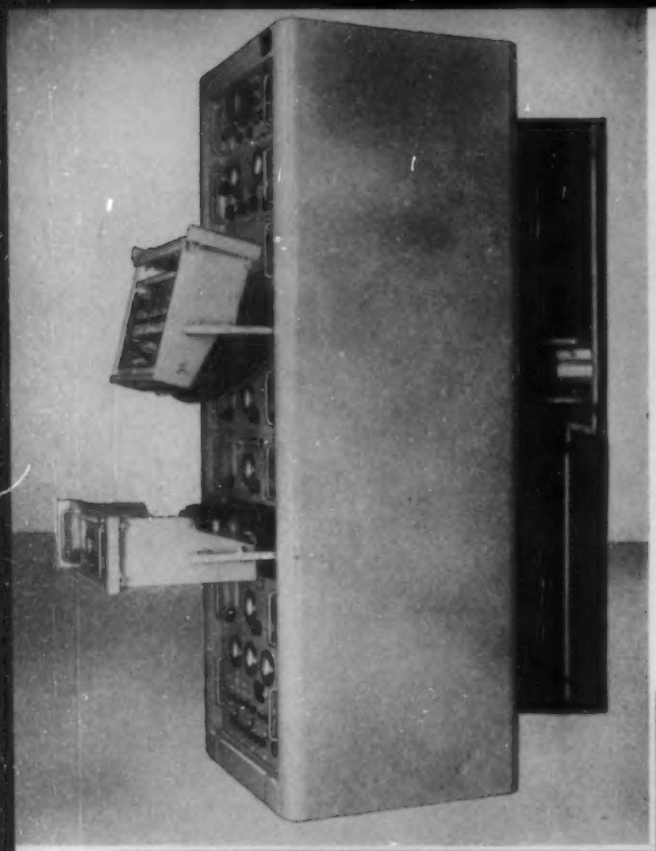
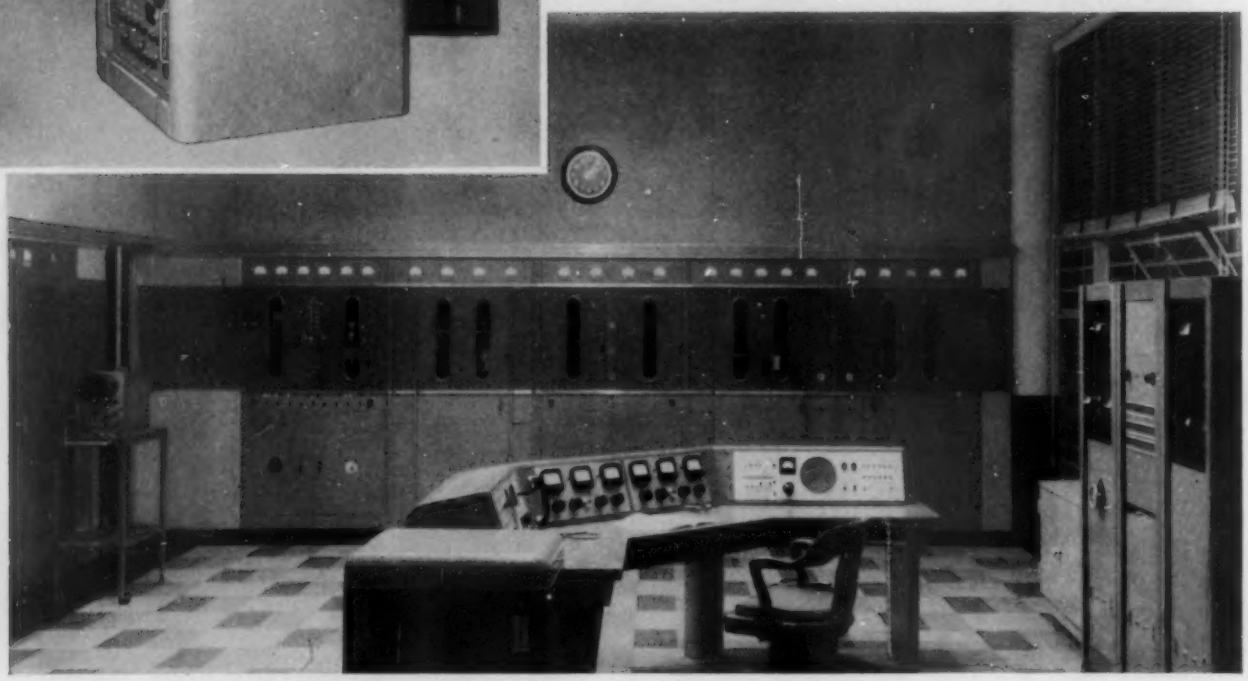


Fig. 2 (Left)—Enclosed rack, drawer-type construction usually best adapted to large or heavy units, which can be withdrawn easily from the front. The units shown are mounted on ball-bearing slides having facilities for rotating to permit convenient access to components for testing or servicing. Flexible cables interconnect the various units and supply power, thus permitting operation in the withdrawn position.

Fig. 3 (Below)—This 50-kw radio broadcast transmitter employs "walk-in" cabinet design. Accessibility to equipment is obtained by removing the front panels or opening hinged doors. Interlock switches disconnect dangerous voltages from the equipment when panels are removed, to protect personnel. This construction, for large installations, is inexpensive and provides good flexibility for mounting of components. Attractive styling is readily accomplished by the simplicity of regularly placed glass panels in doors and orderly placement of meters across the top. All operators' controls and meters are functionally and attractively located at the console.



of subdivision of the equipment into units, and the location of the installation. Knowledge of the location of the installation is an important consideration since it may determine accessibility from the rear and sides.

Rack Construction

Direct-mounting rack construction is that in which units of the complete equipment mount directly on the vertical rack mounting irons, as shown in Fig. 1A. The chassis may be either horizontal or vertical; often both types can be used together in the same rack. Advantages of direct rack mounting are simplicity and economy. Where appearance is relatively unimportant, the rack may be a simple angle-iron framework, fitted with "standard" stock panels and chassis.

Appearance improvement can be accomplished in two ways. One way is to turn the rack into a completely enclosed cabinet, equipped with styling strips down each side in front to hide the panel mounting screws, as shown at (B). Large equipments can utilize a number of these cabinet racks placed side by side at point of installation with the advantage that attractive housings can be assembled from standard components; and the completed installation will possess a finished appearance even if placed out in the open in a large room. The other way to improve appearance of a rack mounted installation keeps the simple open-type rack construction, but the racks are placed side by side from wall-to-wall and extend from floor to ceiling, so that only the equipment front is displayed, as shown at (C). Where the equipment does not occupy the entire space between floor and ceiling or wall to wall, a false wall or panel can be placed at the ends or to close up the space to the ceiling to give the desired effect. A door can be located in the false wall to provide access to the rear of the equipment.

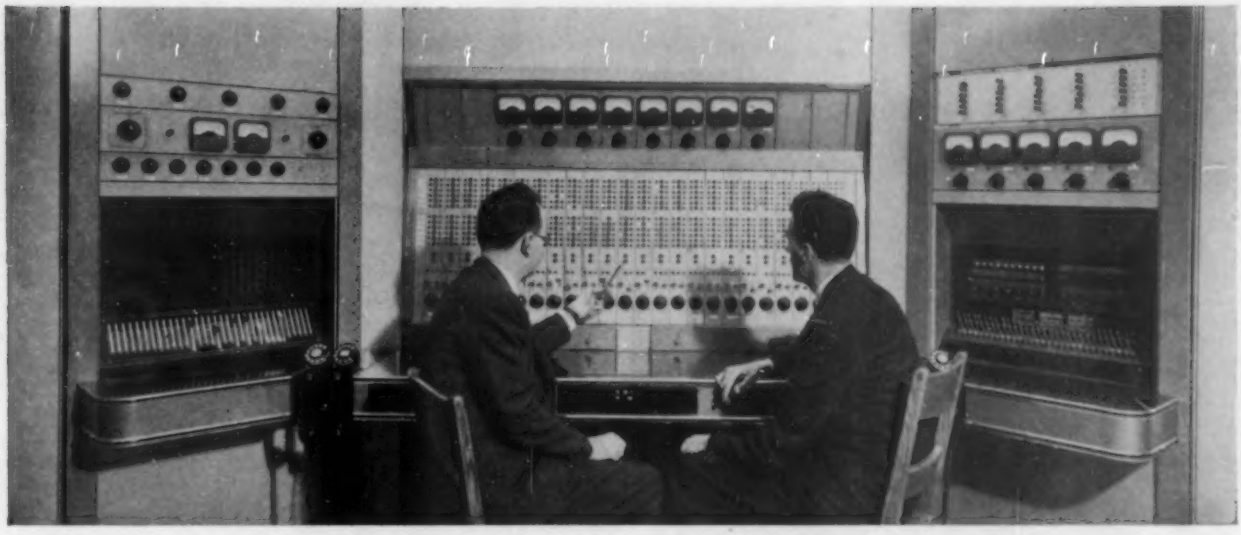


Fig. 4—Valuable floor area is saved by incorporating the operator's control desk into the equipment rack as illustrated here. Remote cabling is also avoided, and a very compact overall design results. Appearance problems are often more difficult to solve, however, since a purely functional location for meters and controls may not be the most attractive.

There are some limitations to direct rack mounting. Large size or heavy weight of individual units may make their installation or removal difficult, since the only support is at the front panel. When panel screws are loosened, units may have to be hand supported from the rear as well as from the front. In locations where the rear of the equipment cannot be accessible, this type construction is not recommended.

Drawer mounting is better than direct mounting where frequent accessibility is required, such as for frequent or extensive servicing. Construction of units is similar to that for direct mounting; however the units slide in on shelves (where economy is paramount) or on ball bearing slides which are mounted on the rack. A more elaborate arrangement permits the units, when pulled out on their slides, to be rotated about a horizontal axis for ready accessibility to all parts, as shown in Fig. 2. Electrical connections to units and interconnections between units can be made by flexible cables to permit the equipment to operate when pulled out for servicing. An alternative arrangement is for the units to plug in as they are pushed into position, in which case they must either be transferred to a separate bench set-up for testing and servicing or be provided with special interconnecting cables between the rack sockets and unit plugs to supply power when in the withdrawn position.

Drawer construction can be applied to either open or cabinet type racks, though it is normally used with the cabinet type. It's advantage is convenient handling of relatively heavy units; its main disadvantage is cost, which often precludes its use where maximum economy or competitive price are major factors.

"Walk-In" Cabinet Construction

Where units and components are heavy and bulky, "walk-in" cabinet construction is often the best. Usually constructed with an angle-iron framework, the panels are of sheet metal and glass, some of which may be hinged or completely removable for access to the interior, as shown in Fig. 3. This construction allows for great flexibility of layout, since internal members can be arranged to support components as desired. A neat frontal appearance can result from well-designed panels. In equipments employing dangerous voltages, interlock switches may be located on all movable panels for safety of personnel. This type construction is particularly adaptable to such equipment as radio transmitters, high voltage test equipment, and industrial radio-frequency generators.

Console Cabinet Construction

Console design is primarily useful for mounting equipment controls, meters, and other apparatus which must be readily and continually accessible and visible to an operator. One or more consoles may be used in conjunction with rack mounted equipment as in Fig. 3, although it is often cheaper to build an operating position of pseudo-console form into the rack design, as shown in Fig. 4. A separate console presents styling problems because it nearly always forms part of a "prestige" installation and is usually visible from all sides. It is generally an expensive form of construction both in terms of actual construction cost and in utilization of floor space, thus comparatively restricted in application.

SECONDARY CONSIDERATIONS

In designing new apparatus, or when basic considerations allow for more than one type of construction, decision may be determined by secondary considerations. An important factor is the *method of wiring*, whether within the bays of a rack mounted installation, within the compartments of a "walk-in" cabinet, between bays or compartments, or between the equipment and other apparatus. With installation of audio or video control gear, for example, the multiplicity of connecting cables gives the

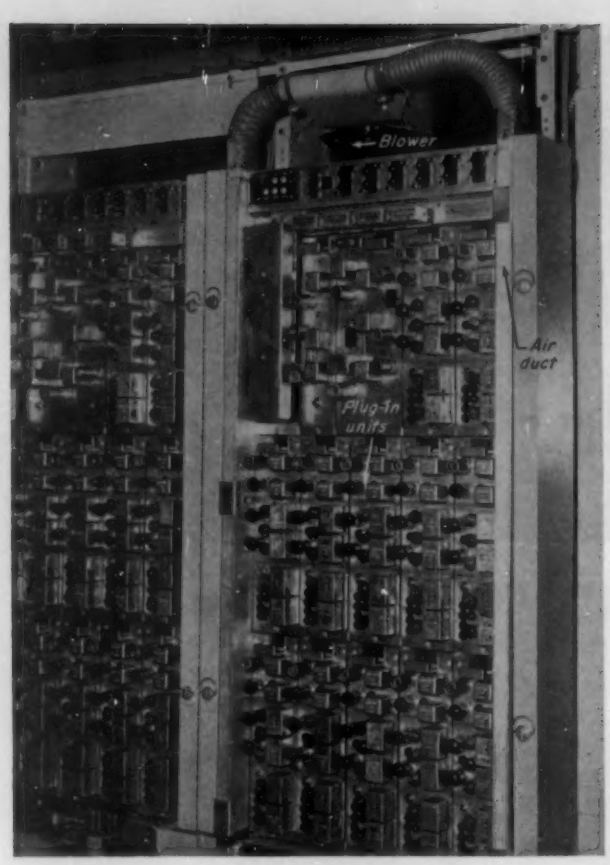


Fig. 5—Example of simple, open-type rack construction with small plug-in chassis units used for telephone carrier terminal applications. In addition to convection air currents for cooling, forced ventilation is provided through ducts in the rack.

open type of rack a definite advantage because of the greater accessibility it provides for changes or repairs to the wiring. Also, the open rack lends itself readily to the provision of overhead-cable trays or under-floor ducts which contribute to neatness of installation. Radio transmitters, however, have fewer connections, and these are of much heavier gauge wire; thus the presence of cabinet walls is an advantage which facilitates the support of the heavy leads in position. Open construction makes for easier wiring and maintenance of the equipment; thus, the console cabinet is normally the poorest in this respect. Yet, hinged panels and mounting framework can be designed to minimize this disadvantage.

Another important consideration is the method of *terminating external connections* to the equipment. With telephone or broadcast audio installations, such terminations may consist of separate distribution frames carrying a large number of terminal strips and located apart from the equipment proper. Where only few terminations must be made, location of terminals in each bay or compartment is generally most suitable.

Ventilation is also important to consider. Large electrical or electronic equipment produces considerable heat; many components of such equipment must be protected from high ambient temperature. The open rack has the obvious advantage for heat dissipation; but if forced ventilation is found necessary, more difficulty is experienced in confining the draft of air to the high ambient areas than with cabinet construction. In wall-to-wall ceiling-to-floor installations, cool filtered air can be blown into the space behind, the heated air being forced out through spaces between the panels and holes in jack strips and other components. In addition to cooling, the flow of clean air through the installation from back to front helps to prevent deposition of dust and dirt on contacts and other vulnerable points.

Although a properly designed cabinet with forced ventilation is superior to open construction for elimination of dust and dirt, the cabinet rack which depends on large louvered areas and convection for ventilation, furnishes little protection against dust and adds to cleaning difficulties. With telephone equipment, a compromise is made by using open racks with dust covers over all vital parts—an excellent solution in this case.

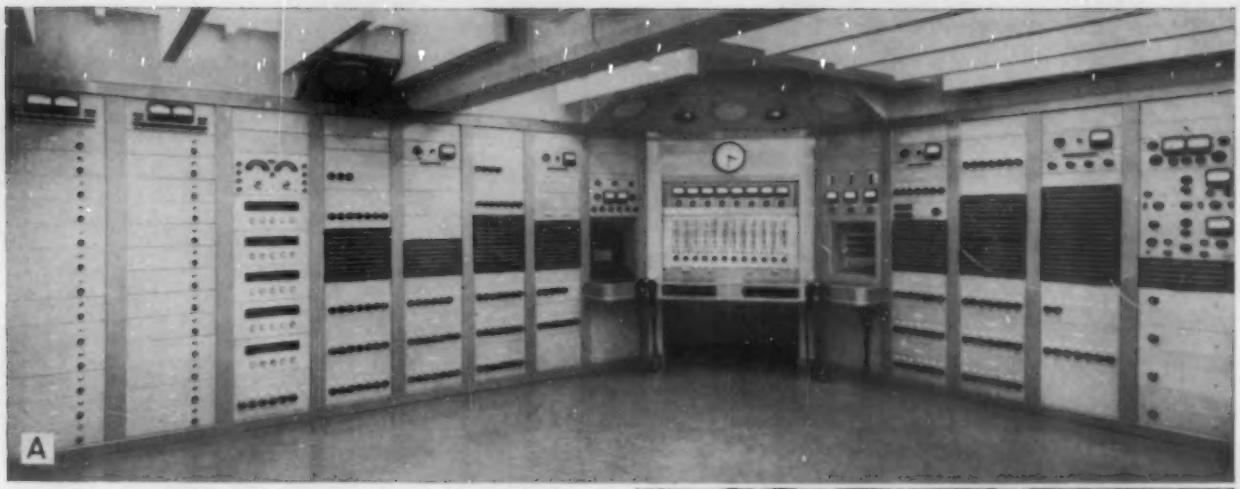
Safety must always be considered where high voltages exist, and some reliable and tamper-proof interlock switch must be installed to operate when panels are removed or doors opened to give access to lethal points in the equipment. When dangerous voltages are present, cabinet construction is almost mandatory. Special precautions must be taken where it is possible to close the door after entering an enclosure. Other safety precautions to consider include the methods for anchoring racks and cabinets to the floor and ceiling and the avoidance of sharp projections or edges which might tear clothing, or cause cuts and bruises when passing close to the equipment. When the control desk is to be built into the equipment, as in Fig. 4, factors to be considered include: (1) location of controls, meters, etc. for efficient operation, (2) overall appearance, (3) accessibility to units for repair and adjustment, (4) illumination, (5) best height for working space depending upon whether operators sit or stand, and (6) how best to reduce or eliminate distracting influences on operator's alertness.

When meters must be located remote from the operator, special large meters may be used, or alarm devices can be employed to warn of departure from normal conditions. Often the location of important meters at proper height for observation imposes serious restriction on arrangement of other components. The same applies to frequently operated controls, switches, and patching facilities which must be placed convenient to the operating position.

When operator's requirements make it necessary to have controls, meters, patching facilities, etc. at certain convenient heights, it may be impossible to utilize effectively all space in the cabinet immediately behind the operator's position. In such cases it may be necessary to increase the number of racks or size of compartments accordingly.

Lighting of large installations, as important as it is, has little influence on the overall equipment design, but it may determine arrangement of apparatus within the allotted space. By employing internal illumination for such components as meters, dials, and control knobs, the necessary level of external illumination is reduced and shadow problems are minimized.

Generally, simplicity of styling is favored with emphasis on straight lines rather than curves, except that most corners and edges are broken with small radii, which soften the extreme severity of rectilinear design.



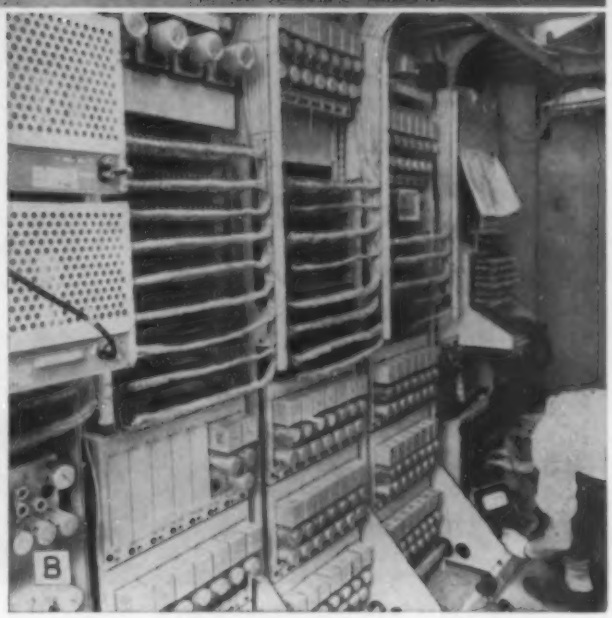


Fig. 6—This master control equipment for the Canadian Broadcasting Corporation's studio center in Winnipeg is an L-shaped wall-to-wall, floor-to-ceiling installation with operating position functionally located across the corner. The meters are at eye-level height or slightly above. Only a few steps are required for quick programming at the jack panels. The styling is simple and functional but attractive. Adequate access at the rear is provided as shown at (B) for inspection and servicing.

TYPICAL INSTALLATIONS

The telephone carrier terminal equipment, shown in Fig. 5, is composed of small plug-in units mounted on simple open-type racks. The rack members are enclosed to form ventilation ducts fed through short lengths of flexible pipe from the blower shown at top. Accessibility is excellent to all parts of the equipment; good utilization is made of floor space, since racks of this type may be lined up in rows. Appearance is secondary so there is very little styling; yet, the overall effect is one of neatness and efficiency.

Master control equipment installed in the Canadian Broadcasting Corporation's studio center in Winnipeg, Manitoba, is shown at (A) in Fig. 6. The comparatively small size of the individual units made possible the use of inexpensive rack mounting. For appearance and accessibility, the open rack wall-to-wall arrangement was chosen. A rear view of a section of the equipment is shown at B, demonstrating the accessibility from the rear. Because more than one complete side of the room was required to accommodate the 150 units, the L-shape design was chosen which provides a functional location for the main operating position in the form of a built-in desk across the corner. Controls are conveniently placed, and the meters above them are tilted downward for easy reading.

Cabinet racks with drawer mounting were chosen for the multiplex teletype equipment shown in Fig. 2, because the electronic units are larger than in Fig. 6. Easy accessibility to below-chassis wiring is obtained by the "tip-up" arrangement shown. The racks are much more substantial and also more expensive than those shown in Fig. 6. The blower for ventilation is mounted on the rear door and takes air in through a filter in the door panel. A minimum of strictly appearance styling is employed, rather there is a reliance on good proportions and a generally massive appearance to achieve the desired effect.

The typical broadcast radio transmitter shown in Fig. 3 illustrates the large scale, walk-in construction of the cabinets. The actual arrangement of components depends as much on electrical considerations as on mechanical, and the open nature of the assembly helps in maintenance and repair work. The control console is typical of this type construction, expensive for the amount of equipment it mounts but justified for the comfort and convenience afforded the operator. Appearance styling of the transmitter is mainly accomplished by the pleasing arrangement of the windows in the front panels and neat arrangement of the meters along the top; the console attractiveness depends on its proportions, shape, and rounded edges.

EDITOR'S NOTE—Future articles dealing with equipment housing problems will include material on cabinet ventilation and cooling, and the selection of cooling motors and fans. Although the current article specifically relates to housing electrical and electronic equipment, the fact that many mechanical components must also be housed to protect such equipment against dust, humidity, and other environmental factors, should make the principles described universally applicable.

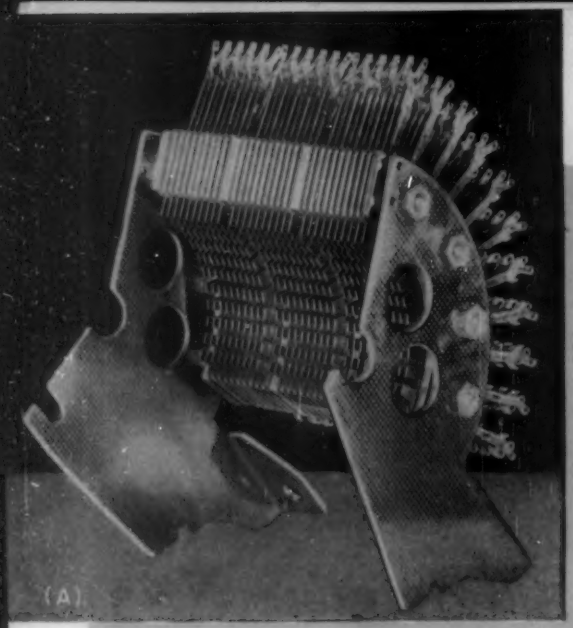


Fig. 1—A completed contact bank for a two-motion selector switch, as used in telephony and other applications, is shown at (A). The 330 separate contacts on the bank are obtained by assembling 30 stampings of 11 contacts each. These contacts are produced on a new "rapid-fire" small stamping press shown at (B), featuring new die construction. This press was developed in West Germany to reduce material waste but it also saves 70 per cent in labor cost. A relatively unskilled operator easily handles the entire operation of stamping and stacking the contacts for an automatic selector switch.

Fanned Stamping Cuts Costs . . .

• • • with over 70 per cent savings both in labor and materials on small stampings. A "rapid-fire" automatic method replaced the usual progressive tool approach without additional tool cost.

While this development came from abroad, it is particularly interesting since both labor and material costs are substantially reduced. Because of the higher ratio of labor-to-materials costs in the United States than in Europe, designers in this country normally look first to mechanization and automatic control when considering means of cutting costs; Europeans logically concentrate to a greater degree on cutting down on materials, which are in relatively short supply there. But the idea behind this cost reduction method has broad application here.

IN A RECENT COMPLETE REVISION of piece-part production and assembly methods for two-motion-selector contact banks Fig. 1 (A)., Mix and Genest, a Division of Standard Elektrizitats-Gesellschaft A. G., associate of International Telephone and Telegraph Corporation in Stuttgart, Germany, developed a new way of producing stampings for the banks. The operation, shown at (B) in Fig. 1, turned out to be a two-edged approach to the cost-cutting problem, for it not only reduced by 71 per cent the amount of brass required for the stampings, but it also reduced direct labor

Fig. 2—(Above) The use of material in coils instead of the 5 ft. long strips which were formerly hand-fed to the machine, contributes to cost savings.

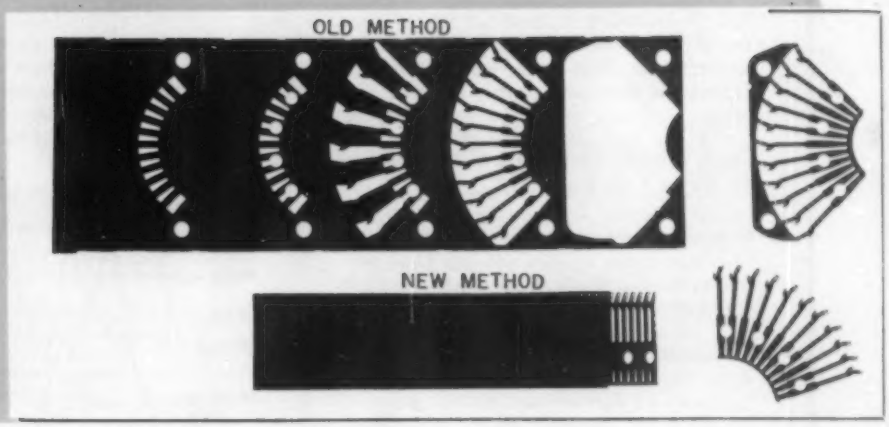


Fig. 3—(Right) Comparison of material required by the standard progressive-die operation and the new "rapid-fire" method. A combination cutting and punching die cuts and fans the contacts, leaving them joined at one end.

by an identical 71 per cent. Tooling costs are no higher than for the old method.

The area of the brass strip required to produce five stampings was reduced from 5½ x 16½ in. (91 sq in.) with the old method to approximately 2½ x 10¾ in. (26.4 sq in.) with the new design. The five stages in the punching process with the old method are shown in the top illustration of Fig. 3. A progressive tool was employed in a standard punch press, and each stroke initiated by the operator produced the five stages shown. The soldering holes, although shown punched in the top picture of the completed part, were actually punched in a separate operation on another machine.

With the new process the machine delivers 11 rapid-fire automatic strokes for each stamping, and works continuously, ejecting on every 11th stroke a spread stamping with soldering holes already punched as shown in the lower illustration in Fig. 3. The machine operates at 220 rpm, producing 20 completed fans each minute.

When the old process was in operation, the outside scrap of each of the 30 stampings in the bank, shown in Fig. 1(A), was trimmed off with a notching tool after assembly. The stampings produced by the new set-up require no outside trimming; they are cut apart on one end, left attached at the other, and fanned out—all by a single die stroke. Final separation is accomplished in a punch press with a shearing die after tightening up in the assembly.

Considerable reduction in direct labor is achieved by use of material in coils, Fig. 2; with the old method, flat strips about 5 ft long were fed to the machine by hand.

At the same time the new punch-press operation was begun, other piece-part production and assembly methods were simplified so the contact banks are now produced with 85 per cent less direct labor than previously required.

Applications of Differential

Known for its mechanical advantage, the differential winch is a control mechanism that can supplement the gear and rack and four-bar linkage systems in changing rotary mo-

ALEXANDER B. HULSE, JR. and ROBERT AYMAR
Factoring Instruments & Devices, Inc., Brooklyn, N. Y.

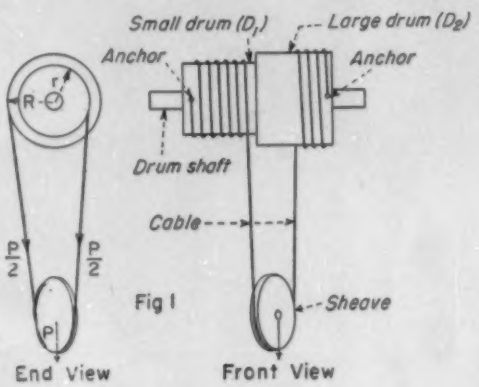


Fig 1

FIG. 1—Standard Differential Winch; consists of two drums D_1 and D_2 and a cable or chain which is anchored on both ends and wound clockwise around one drum and counterclockwise around the other. The cable supports a load carrying sheave and if the shaft is rotated clockwise, the cable, which unwinds from D_1 on to D_2, will raise the sheave a distance

$$\text{Sheave rise/rev} = \frac{2\pi R - 2\pi r}{2} = \pi(R - r)$$

The winch, which is not in equilibrium, exerts a counterclockwise torque.

$$\text{Unbalanced torque} = \frac{P}{2}(R - r)$$

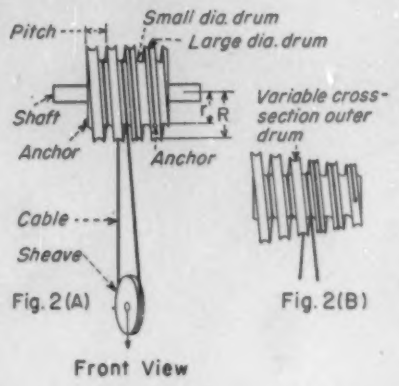


Fig. 2(A)

Fig. 2(B)

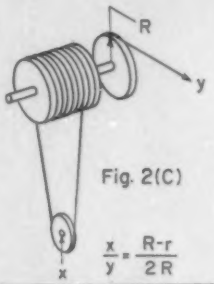


Fig. 2(C)

R	r	x/y
3	$2\frac{15}{16}$	1/96
1	$\frac{63}{64}$	1/128

FIG. 2(A)—Hulse Differential Winch*. Two drums, which are in the form of worm threads contoured to guide the cables, concentrically occupy the same longitudinal space. This keeps the cables approximately at right angles to the shaft and eliminates cable shifting and rubbing especially when used with variable cross sections as in Fig. 2(B) where any equation of motion can be satisfied by choosing suitable cross sections for the drums.

The axial thrust is equal to

$$\text{Pitch} \times \text{Load}$$

Fig. 2(C) shows typical reductions in displacement.

*Pat. No. 2,590,623

Fig. 3(B)

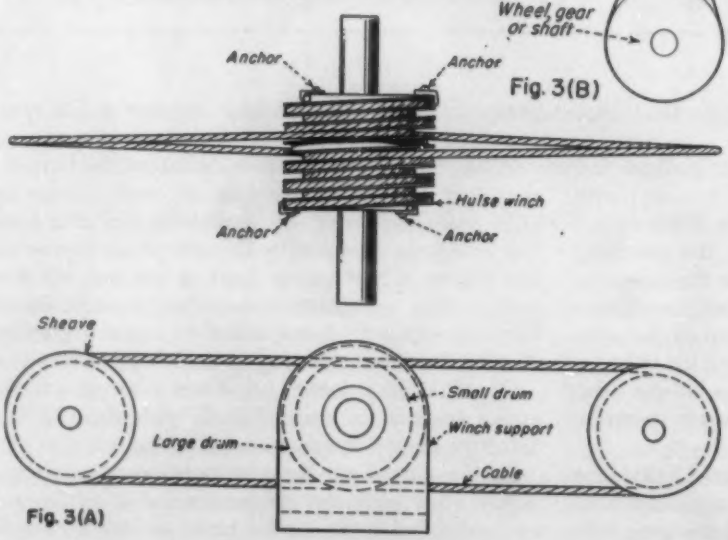


Fig. 3(A)

FIG. 3(A) Hulse Winch with Opposing Sheaves. This arrangement which uses two separate cables and four anchor points can be considered as two winches back-to-back using one common set of drums. Variations in motion can be obtained by: (1) restraining the sheaves so that when the system is rotated the drums will travel toward one of the sheaves; (2) restraining the drums and allowing the sheaves to travel. The distance between the sheaves will remain constant and are usually connected by a bar; (3) permitting the drums to move axially while restraining them transversely. When the system is rotated, drums will travel axially one pitch per revolution, and sheaves remain in same plane perpendicular to drum axis. This variation can

Winch to Control Systems

tion into linear. It can magnify displacement to meet the requirements of delicate instruments or be varied almost at which to fulfill uncommon equations of motion.

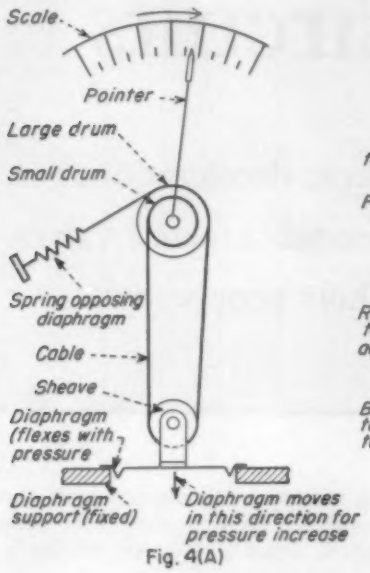


Fig. 4(A)

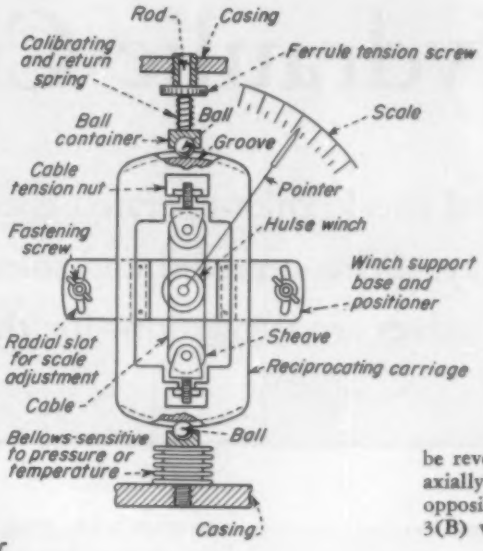


Fig. 4(B)

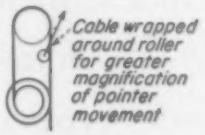


Fig. 4(C)

be reversed by allowing sheaves to move axially; and (4) sheaves need not be opposite but can be arranged as in Fig. 3(B) where a winch rotates a wheel.

FIG. 4(A)—Pressure and Temperature Indicators. A pressure change causes the diaphragm and sheave to move vertically and the pointer radially. Equilibrium occurs when spring force balances actuating torque. Replacing diaphragm with a thermal element changes instrument into a temperature indicator. Two sheaves and a reciprocating carriage, Fig. 4(B), are based on the principal shown in Fig. 3(A). Carriage is activated by pressure or temperature and is balanced by a spring force in opposite end. Further magnification can be obtained, Fig. 4(C), by wrapping cable around a roller to which pointer is attached.

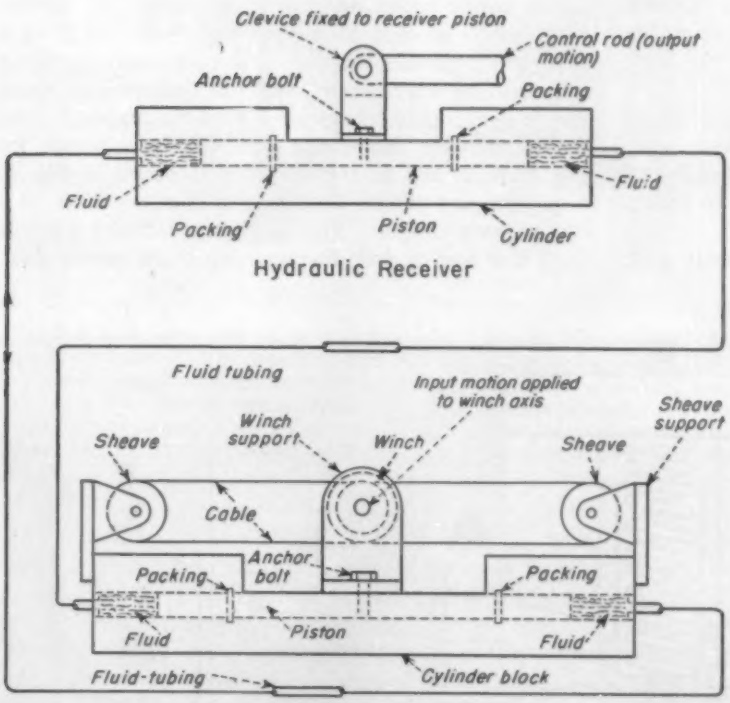


Fig. 5 Hydraulic Sender

FIG. 5—Hydraulic Control System Actuated by a Differential Winch. Used for remote precision positioning of a control rod with a minimum of applied torque. The sending piston, retained in a cylinder block, reciprocates back and forth by a torque applied to the winch shaft. Fluid is forced out from one end of the cylinder through the pipe lines to displace the receiving piston which in turn activates a control rod. The receiver simultaneously displaces a similar amount of fluid from the opposite end back to the sender. By suitable valving the sender may be used as a double-acting pump.

Directional Valves For Hydraulic Circuits

Includes: Standard check, pilot-operated check, deceleration, four-way, spring-centered and solenoid-actuated valves. Besides types of valves are suggestions for their proper use.

WARREN BROWN, Vickers, Inc.

DIRECTIONAL VALVES are used in hydraulic circuits to start, stop, accelerate, decelerate and control the direction of motion of a hydraulic unit. They may be operated by manual, mechanical, hydraulic or electrical means. Table I classifies the commonly used types by method of actuation and type of spool.

CHECK VALVES. Standard check valves, Fig. 1, allow free flow in one direction only and consist of body, seat, poppet (or ball) and spring. The poppet is usually of hardened steel with an accurately ground taper to insure peripheral contact with the seat.

Flow is unrestricted after pressure at the inlet port overcomes light spring resistance (usually not more than 5 psi). Reverse flow is checked when pressure at the outlet port causes the poppet to return to its seat, forming an almost leakproof seal.

Three modifications of the standard check valve are the suction, spring-loaded and restriction types. The suction check, which is used to prevent cavitation, has a light spring which permits the poppet to open easily for filling pump inlet or other circuit lines. The spring-loaded check valve is designed to set up more than the standard 5 psi cracking pressure and is used generally as a source for pilot pressure, and as a relief valve, as shown in Fig. 2, to protect equipment like heat exchangers from sudden pressure surges. The restriction check, Fig. 1, allows free flow in one direction and limits reverse flow.

Fig. 1—Right angle restriction check valve with removable plug. Flow is free in one direction and restricted in other by orifice in plug. If a solid plug is used, valve becomes a standard check.

Fig. 2—Circuit diagram with J.I.C. (Joint Industry Conference) symbols showing three common uses of check valves. The 50 psi check *E* loaded by spring pressure insures minimum pressure for pilot operation of main four-way valve *D*. Restriction check *F* limits forward ram speed while permitting a free return stroke. Spring-loaded check *C* protecting the heat exchanger acts as a relief valve.

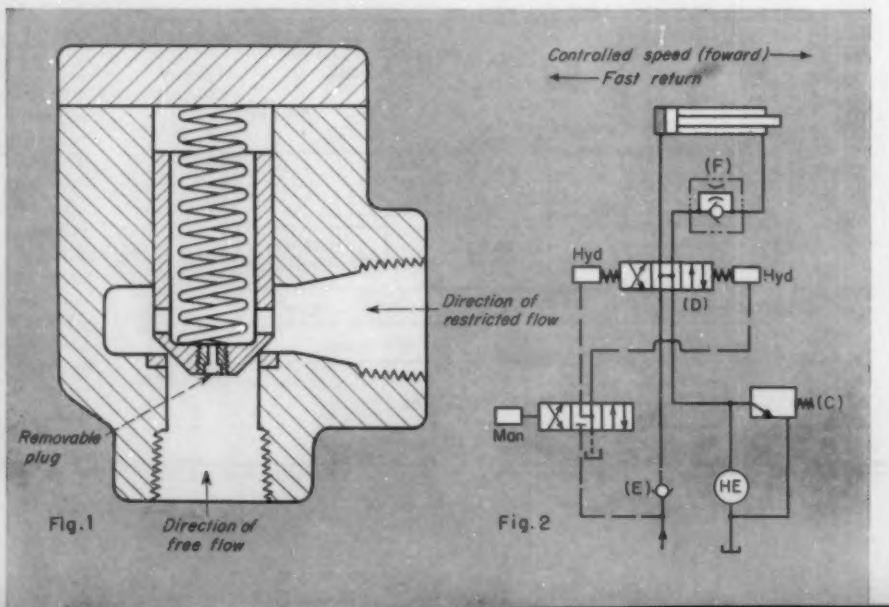


Table I- Classification of Directional Valves

TYPE OF SPOOL			METHOD OF ACTUATION							PIPE SIZE (IN.)										
Poppet	Sliding	Rotary	Flow or pressure	Pilot pressure	Manual	Mechanical	Solenoid	Solenoid controlled pilot operated		1/8	1/4	3/8	1/2	3/4	1	1 1/4	1 1/2	2	2 1/2	3
										NOMINAL FLOW RATE (G.P.M.) (Valve's capacity to pass oil within recommended velocity limits)										
										1	3	6	10	20	30	45	65	100	200	300
Check	✓				✓						✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Pilot operated check	✓				✓	✓								✓		✓		✓		
Deceleration		✓					✓							✓		✓	✓			
Shut-off	✓						✓				✓	✓	✓	✓	✓	✓	✓	✓		
Two-way		✓					✓	✓	✓	✓	✓									
Four-way			✓				✓	✓			✓									
		✓			✓							✓		✓	✓	✓	✓	✓	✓	✓
		✓					✓			✓	✓	✓		✓	✓	✓	✓	✓		
		✓						✓		✓	✓	✓		✓						
		✓							✓	✓	✓			✓						
		✓												✓		✓	✓	✓	✓	✓

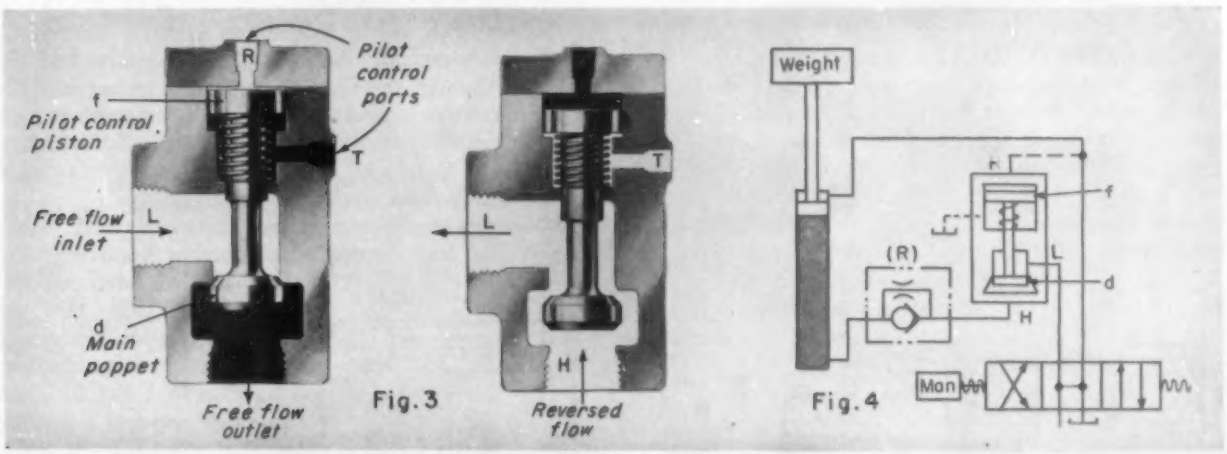


Fig. 3—Check valve with an integral hydraulic plunger actuated by pilot pressure. Free flow is permitted from inlet port *L* to outlet port *H* at all times. No reversed flow is permitted until pressure at pilot port *R* unseats poppet. Valve is closed by spring or by pressure at T.

Fig. 4—Pilot-operated check valve provides positive support to vertical piston. Although the check valve may be leakproof from *H* to *L*, the weight may settle as a result of leakage between piston and cylinder wall. The restriction check *R* is used to control rate of downward piston travel, between the cylinder and the pilot-operated check. The restriction check also prevents free gravity drop of piston and insures the availability of pressure at *r* during piston down stroke.

PILOT-OPERATED CHECK VALVES. These valves prevent reverse flow until the poppet is unseated by pilot pressure applied externally from another part of the circuit. They consist of a basic poppet check with integral hydraulic plunger, Fig. 3, of sufficient area to unseat the poppet when a predetermined force is applied as required. The valve is closed by spring or pilot pressure.

Pilot-operated check valves are used as prefill or filling valves to allow gravity fill of the main ram during a fast approach stroke of a hydraulic press. They also give positive support to vertical pistons that are not counterbalanced, Fig. 4, and lock the pressure in rams or cylinders for clamping, molding or other similar operations. As accumulator shut-off valves, the poppet type construction assures leakproof operation.

In the design of circuits, the opening pressure at the pilot control port is

$$P_o = \left(\frac{A_m}{A_p} \times P_r\right) + P_s$$

where P_o = opening pressure

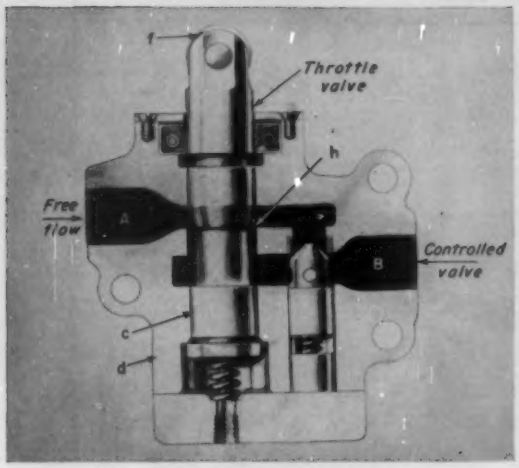


Fig. 5—Normally open deceleration valve. Hardened and ground spool (c) fits closely in body (d) and is normally held in the up position by the spring. In normal position, oil flows freely from inlet port *B* to outlet port *A*. As cam on moving slide depresses roller (f), throttling action restricts opening at (h) to effect desired deceleration. The integral check valve permits free flow from *A* to *B* regardless of position of spool.

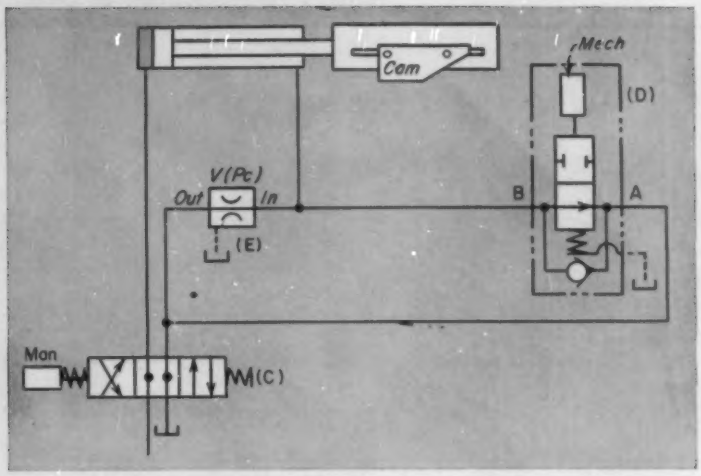


Fig. 6—Deceleration circuit for machine tool traverse and feed cycle. Ram advance begins with shift of four-way valve (C) to admit pump flow to ram. At the end of rapid advance, the adjustable cam depresses the roller follower on (D), throttling and finally blocking flow of exhaust oil. Cam angle controls deceleration rate. During feed, rate is controlled by limited passage of exhaust oil through the flow control (E). Ram return begins with shift of (C) directing flow through (D), by way of the integral check, and into the rod end of the cylinder.

A_m = area of main seat
A_p = area of pilot control piston
P_r = pressure at free flow outlet
P_s = pressure rating of spring

DECELERATION VALVES. Deceleration valves, Fig. 5, are used to gradually accelerate or decelerate hydraulic pistons or motors during a change in oil flow rate. Four variations are: normally open, with or without a check valve; and normally closed, with or without a check valve. They have a spool type plunger with a roller follower and the built-in checks permit full return flow. In the normally open type, spring loading holds the plunger open for normal flow. As cam action depresses the plunger, valve opening decreases, gradually restricting flow and decelerating the piston. If desired, continued camming can ultimately stop flow completely.

The point at which deceleration starts is determined by the pump pressure, the MV^2 of moving parts, and the flow rate through the valve. Since these factors vary for different machines, careful cam design is important. Test data are usually required to insure a smooth, shock-free transition; in some cases the taper on the valve spool must be modified for best results.

When deceleration valves are properly applied to the traverse and feed circuits of production machinery, the change point is located precisely and held consistently. This permits accurate positioning of tools and minimizes nonproductive travel in feed, Fig. 6. Their construction prevents a feeding cycle from going into rapid advance if the valve sticks in depressed position.

In traverse and feed circuits, valves using sliding spools permit some internal leakage past the spool when there is meter-out pressure at the controlled flow port and no pressure at the free flow port. Although this leakage is usually not more than a few cubic inches per minute, allowance must be made in cylinder size if a slow accurate feed rate is required. Best feed control is achieved when flow rate is large in comparison to anticipated leakage.

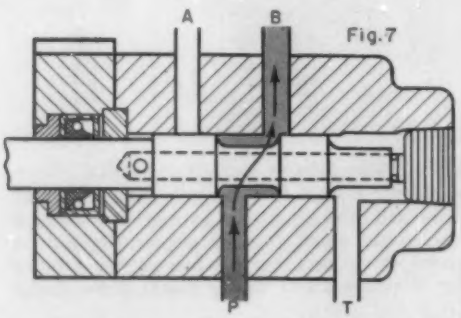


Fig. 7—Two-way sliding spool valve. When shifted to the left, port *A* is opened to port *P*, and *B* is blocked. In both positions, internal leakage is permitted to drain back to the reservoir through tank port *T*.

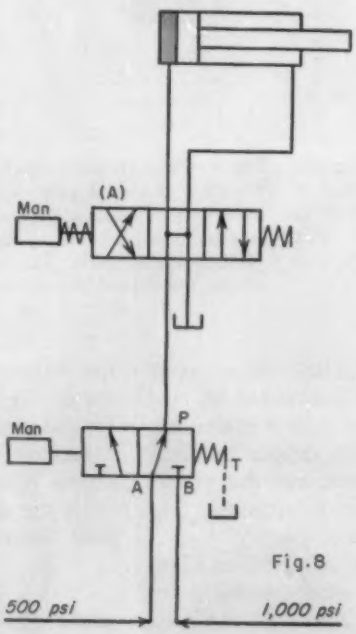


Fig. 8—Typical two-way valve circuit for alternately applying 500 and 1,000 psi pressures to a piston. Pressures are blocked when not in use and four-way valve *A* directs flow to either end of the cylinder.

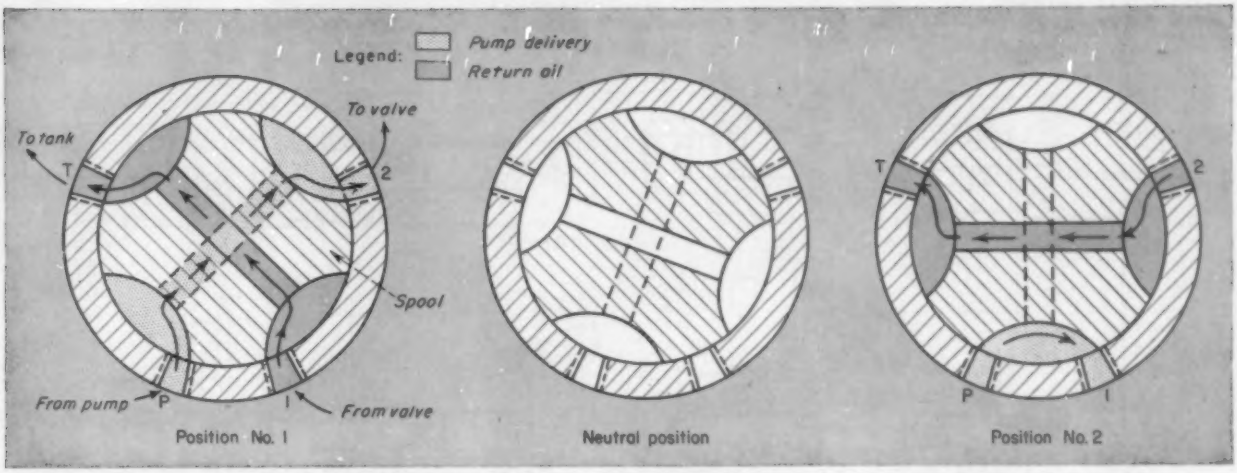


Fig. 9—Rotary four-way valve. Hardened and ground spool having milled grooves and interconnecting drilled holes rotates in a cast iron body. The spool may be rotated manually, mechanically or by solenoids.

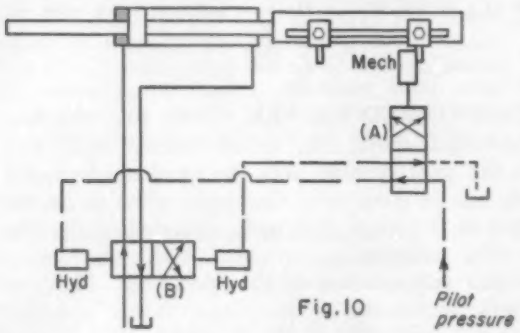


Fig. 10—Circuit used for grinder tables in which a rotary four-way valve directs flow from a pilot source. The reciprocating head with adjustable reversing cams shifts the rotary four-way valve *A* causing pilot pressure to shift the main four-way valve *B*.

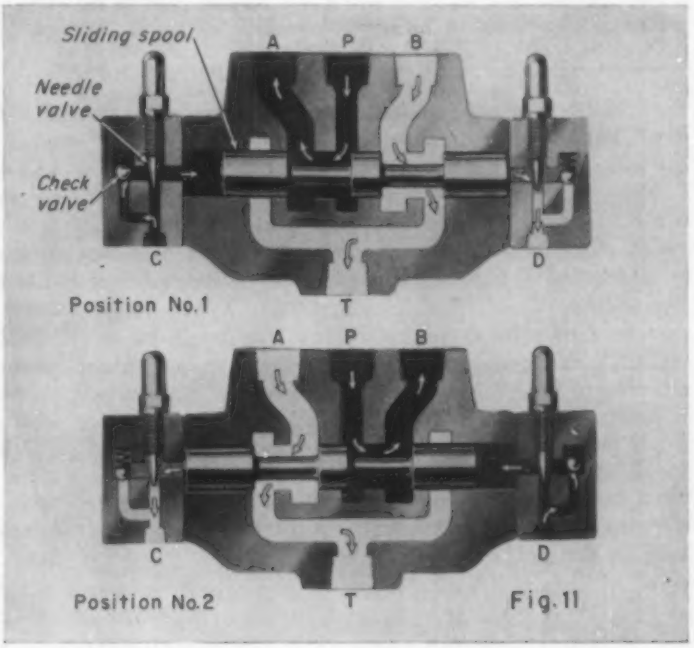


Fig. 11—Two positions of a pilot-operated four-way valve. Pilot pressure applied at *C* or *D* shifts spool at a rate controlled by needle valves which throttle exhaust pilot oil. Pilot pressure is admitted unrestricted by check valves.

TWO-WAY VALVES. Usually containing a sliding spool which is returned by spring pressure, two-way valves, Fig. 7, are adaptable to manual, solenoid, or mechanical control, and provide a choice of two flow paths exclusive of the valve's center position.

Fig. 8 shows a typical cylinder circuit using a two-way valve to permit alternate application of 500 and 1,000 psi to the piston. These valves are also used in pilot or control circuits. Their seals are drained through the tank port which should be connected directly to the reservoir to avoid subjecting the seals to high pressure.

FOUR-WAY VALVES. Four-way valves which provide four flow paths exclusive of the valve's center position path can be either of the rotary or sliding spool type; the larger sizes usually have a sliding spool. They are used to control pistons, motors or other valves and can be actuated by any of the known methods.

Usually consisting of a hardened and ground spool within a cast iron body, the rotary type, Fig. 9, is frequently used in grinder table circuits to provide head reciprocation, Fig. 10, and as interlocks in pilot pressure control circuits. The latter provides a control similar to switches in electrical circuits. Rotary valves are generally confined to sizes up to 3 gpm capacity and 1,000 psi operating pressure because of the difficulty in obtaining large passages to permit higher flow rates while retaining adequate sealing between spool and body.

The two-position pilot-operated valve with a sliding spool construction, used as the main four-way valve in Fig. 10, has a maximum operating pressure of 2,000 to 3,000 psi. The spool has three lands, Fig. 11, which is typical of pilot-operated units. Pilot pressure is admitted unrestricted by check valves and the shifting rate of the main spool is controlled by needle valves, also called pilot chokes, which throttle exhaust pilot oil. In Fig. 10

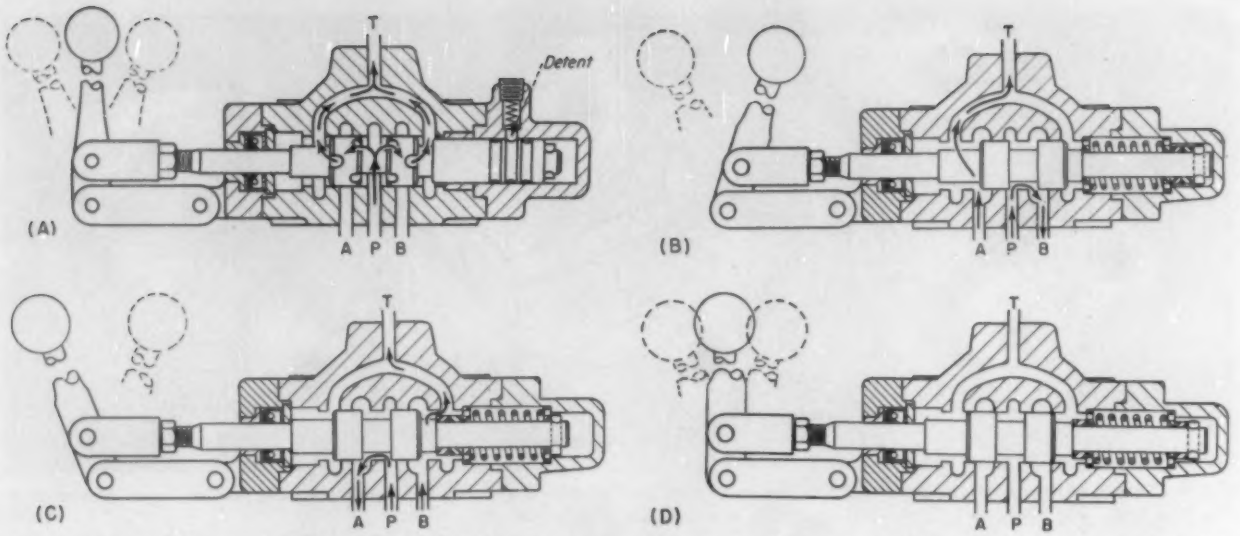


Fig. 12—Manually operated four-way valves: (A) three position valve shown in its centered position located by detent falling into groove; (B) two position valve with spring pressing spool to the right, and (C) to the left; (D) three position valve with its sliding spool retained in its centered position by spring pressure.

this throttling action controls the reversal rate of the head. Because of high pressure oil seals, the tank port (T) can withstand the full pressure of the system.

Manually actuated four-way valves with a sliding spool construction fall into four classifications: (1) detented, (2) spring offset to move stem in, (3) spring offset to move stem out, and (4) spring centered; these are illustrated in Figs. 12(A), (B), (C) and (D) respectively. When designing circuits for these types, the tank line should be unrestricted and connected directly to the reservoir rather than to other returns which might impose high surge pressures on the tank port seals. Pressure in excess of 5 psi may also react on unbalanced areas of the main spool ends to overcome spring pressure and force the spool to the "out" position. In addition, high pressure in the tank port can be detrimental to the low pressure seal used on the spool extension.

SPRING-CENTERED VALVES. Of the four classifications mentioned above, the spring-centered type, Fig. 12(D), is the most versatile since the spool can be varied to provide one or more extra flow paths when in neutral in addition to the usual four paths obtained in the two extreme valve positions.

One type, with notches in the spool, Fig. 13(A), is used mainly for unloading functions. When hydraulic power is not required, the valve is centered, permitting pump delivery to unload directly to the tank, Fig. 14, thus preventing waste of input power and keeping oil temperature to a minimum.

Another variation, Fig. 12(D), is used where two or more cylinders or motors must be operated independently as in Fig. 15. Each piston can be stopped and held in intermediate positions by centering the spool. Where a fixed displacement type pump is used, an auxiliary

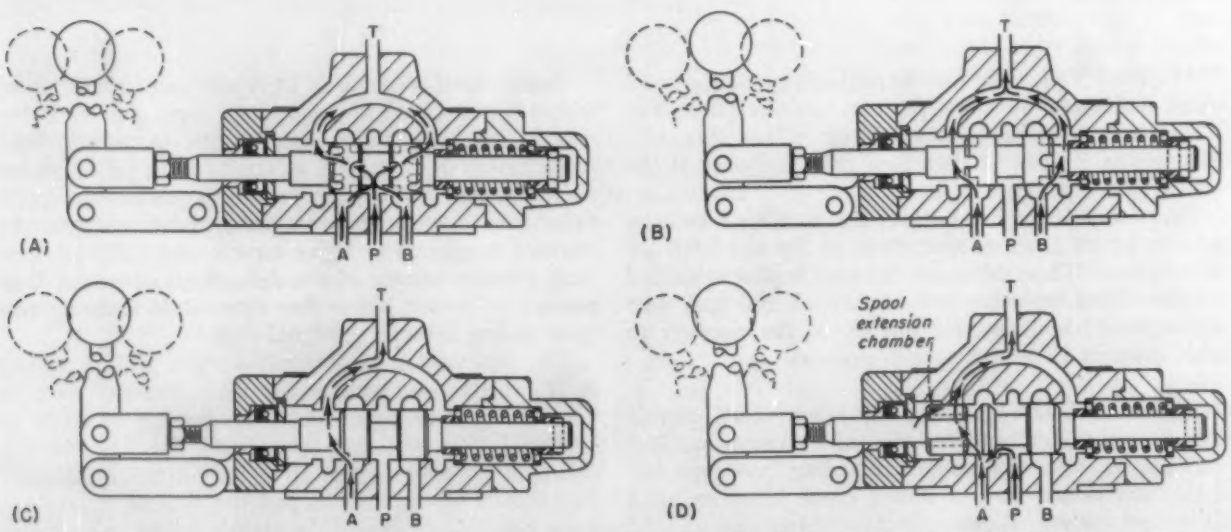


Fig. 13—Variations in spool construction of four-way valves. Typical circuits using these valves are shown in Figs. 14 to 18.

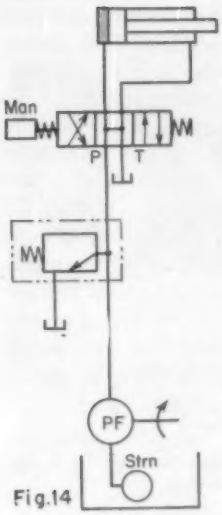


Fig.14

Fig. 14—Four-way valve with spool construction as shown in Fig. 13(A) is used to unload a hydraulic pump. Its neutral position permits pump to unload from *P* to *T*, thus preventing waste of input power and minimizing oil heating. However, when valve is in neutral, the cylinder piston is free to float since no pressure is applied at either end of the cylinder.

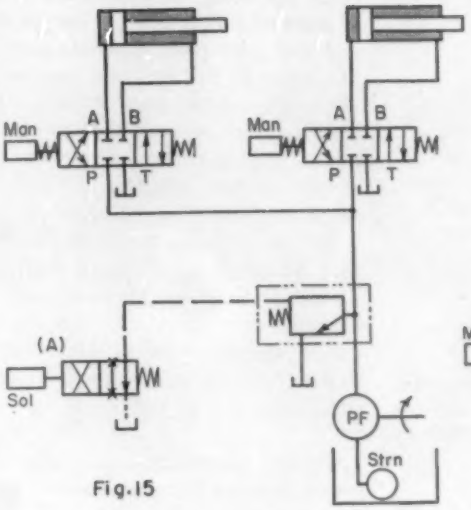


Fig.15

Fig. 15—Two pistons are operated independently and held in intermediate positions by centering their four-way valve which uses a spool as shown in Fig. 12(D). Auxiliary valve *A* vents the relief valve and unloads the fixed displacement pump during idle periods.

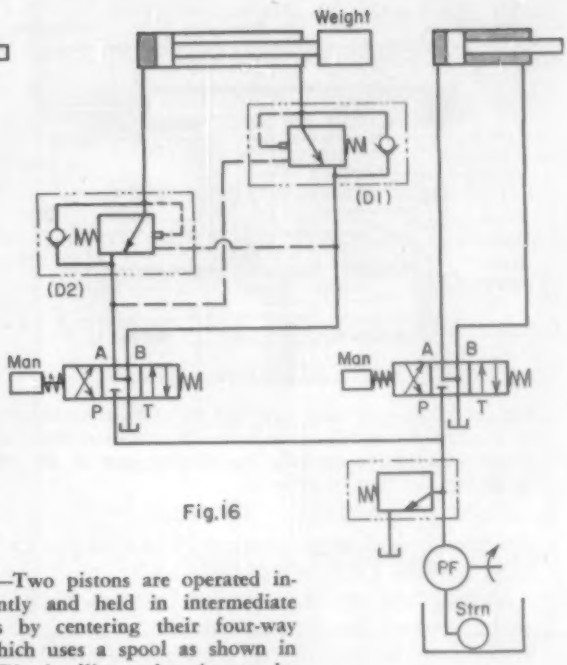
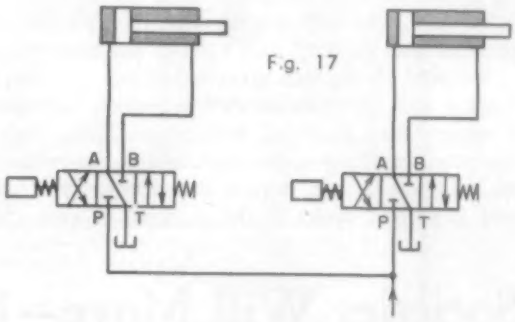


Fig.16

Fig. 16—By using a spool as shown in Fig. 13(B), piston creep is prevented when valve remains centered for an extended period of time. Since ports *A* and *B* are opened to tank when valves are shifted to center, oil flow offers little resistance to cylinder piston movement; therefore, where a heavy or fast moving weight is involved, auxiliary valves (D1) and (D2) provide the desired braking action.



F.g. 17

Fig. 17—Four-way valves holds piston in intermediate positions where, for safety reasons, creep to the left only is acceptable. Spool construction is shown in Fig. 13(C).

valve can vent the relief valve and unload the pump during idle periods.

Piston creep induced by pressure can occur when a valve remains centered for an extended period of time and pump delivery is not unloaded between cycles. Internal leakage past the spool accumulating in the cylinder lines faster than can leak back to the reservoir causes the piston to creep out because the area of the piston at the head end is larger than the rod end. This condition can be remedied by using a modified spool, Fig. 13(B), which opens cylinder ports to reservoir in neutral position. However, the neutral position cannot be used for controlled stopping of pistons which move heavy or high speed loads; therefore, two auxiliary braking valves, are used in the circuit diagram in Fig. 16.

Another application, Fig. 17, is as a safety device in a circuit that prevents creep in one direction.

SOLENOID VALVES. Solenoid operated four-way valves are classified in the same manner as the manual units. Direct actuation by means of small and inexpensive solenoids is used on smaller sizes up to 3 gpm rated capacity. However, the pressure on the tank port must be limited to 5 psi to avoid burning out the solenoid or oil seal leakage.

Above 3 gpm the solenoid is considerably larger and more expensive and recent design trends have been toward valves operated by pilot pressure which in turn is controlled by a solenoid. This combination, Fig. 18, uses a small solenoid valve mounted on a larger valve to control the flow of pilot oil to the larger valve. The advantages of this arrangement are: (1) more compact and easier to mount and service; (2) less expensive; (3) uses smaller solenoids and related electrical controls; (4) smoother acting and induces less shock when shifting; (5) solenoid is interchangeable with smaller valve sizes; and (6) main spool design permits controlled shifting rate.

Pilot pressure of at least 50 psi is needed at all times to shift the main spool. This pressure can be obtained internally from the main pressure port or externally through another connection. The drain which exhausts oil from the ends of the main spool through the solenoid valve must have an unrestricted connection to the tank and not be connected into other main returns which are usually

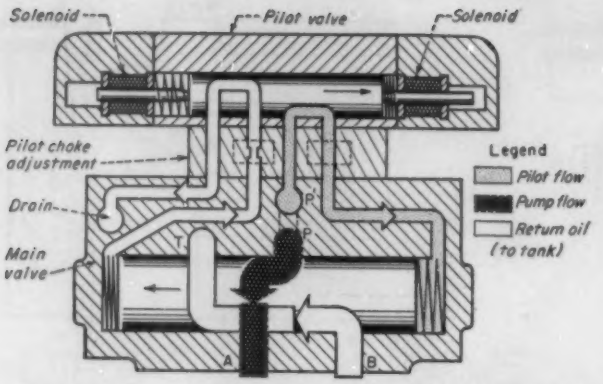


Fig. 18—Four-way valve operated by pilot pressure controlled by a solenoid coupled on its back. The choke actuator between solenoid and valve controls the shifting rate of the valve by regulating the flow of pilot oil.

subjected to high surge pressures. The tank port can withstand 2,000 to 3,000 psi on most models.

Shifting rate can be controlled by sandwiching a pilot choke actuator between solenoid valve and main valve to control flow of pilot oil. The time required for shifting will be at least twice as long as valves operated directly by solenoids. A slow shifting rate reduces starting, stopping and reversing shocks. Shifting time may range from 0.05 sec for a 20 gpm valve to 1.0 sec for a 300 gpm valve, and varies with size of valve, pilot pressure, oil temperature and viscosity, and mass of the main valve spool.

Solenoid life depends upon two factors: (1) frequency of cycling, and (2) duration of energization. A high cycling frequency may raise coil temperature faster than can be dissipated resulting in electrical failure. For ordinary cycles of less than 12 cpm, normal life expectancy is between 1 and 2 million cycles if the solenoid is kept clean and other operating conditions are normal. Additional causes of solenoid failure are: (1) foreign matter between solenoid seat and pole piece prevents proper seating. This causes the solenoid to hum and increases the holding current. (2) Sticky valve spool caused by contaminated oil or back pressure at tank connection increases load on solenoid. (3) Higher line voltage than solenoid rating increases inrush current resulting in greater impact when pole piece contacts solenoid seat.

Not included in this discussion were: valve panels since they are composed of special combinations of valves already discussed; three-way, five-way and six-way valves because of their infreqeunt use and similarity to the four-way valves; and servo valves which are special adaptations of four-way valves and whose importance warrants special consideration.

EDITOR'S NOTE—The following related articles have appeared in recent issues of *Product Engineering*.

"Theory of Hydraulics Flow Control," April 1955, page 161. Equations and sample problems for determining the throttling orifice area of flow control valves and energy losses; experimental determination of hydraulic resistances; the cavitating venturi and its application as a flow limiting device.

"Solenoid Operated Shutoff Valves for Aircraft Hydraulic Circuits," March 1953, page 175. An analysis of circuit requirements and service considerations that influence the selection and application of solenoid shutoff valves in aircraft systems.

"Integrated Design for Solenoid Operated Shutoff Valves," May 1953, page 186. Discusses methods of integrating the design of both solenoid and valve to achieve an overall assembly of minimum size and weight.

"Pilot-Operated Air Control Systems," March 1953, page 214. Types of pilot-operated control valves: pressure operated, bleeder operated and solenoid operated, with circuit diagrams.

"Sequential Operation of Hydraulic Cylinders," June 1951, page 160. Circuit analyses of sequences operated by pressure, cams, electrical and manual controls.

Societies Will Move—But Where?

THE BIG QUESTION before the house—and it is far from answered—is where the Engineering Societies plan to make their home office. This problem is not new, of course, for there has been talk of moving for the last five to ten years. But the subject is being discussed more now than it ever has, and most people feel that a decision will be made before the first of the year.

The present building on 39th Street between 5th and 6th avenues in New York City was erected in 1905 on a grant from Andrew Carnegie. At the time, it was built for the four societies—ASME, AIEE, AIME, and ASCE—title was established with the United Engineering Trustees, Inc., a group set up by the four societies. Now, fifty years later, the building is supported by six additional societies, is overflowing with people, and is in great need of repair.

Lucrative offers were made by a number of cities when word got out that the societies were really out to find a new location. Among the cities interested were: New York, Pittsburgh, Philadelphia, Washington, D. C., Chicago, and St. Louis. The matter is far from settled, but after lengthy meetings, Pittsburgh seems to have the inside track, with New York and Philadelphia running close second.

Pittsburgh's offer was some land and cash adding up to $2-million, plus another $500,000 for research from the Mellon Foundation. Philadelphia is reported to have offered about $1.5-million. New York's offer is a piece of land at Columbus Circle, located at the southwest corner of Central Park, or another location at Broadway and 59th Street. In both cases the land has been offered at far less than the assessed evaluation. Also backing the New York location is engineer, and former president, Herbert Hoover. New York's big proposition is that it is the center of industry and finance, as well as the location of the greatest engineering employment. And looking at it in that light, many people feel that the decision should be made on terms such as those, and to take it off the "auction block."

To date the following facts are known: the president of the American Society of Civil Engineers is on record as opposing the move to Pittsburgh, while the other four did not (In the new arrangement, the Chemical society wants to become a corporate member of the United Engineering Trustees, Inc.); each of the societies have set up committees to evaluate the move, and so far the AIEE has voted (12 to 10) to move to Pittsburgh.

"But," as anyone says, "nothing is definite."

REDUCING COSTS in the drafting room

Simplification of drafting practices has been carried too far—in fact, to the point of complexity. The author agrees with Mr. Gerardi in his article "Should Current Drafting Practices be Further Simplified," *Product Engineering*, May 1954, page 161. But, since money saving is the objective of simplification, all avenues where money may be saved should be investigated—including the long term as well as immediate savings.

Nine Ways to Improve Drafting Room Efficiency

	ITEM	DESCRIPTION
1.	Quick-Adjusting Compass	Big-bow compass can be quickly locked and unlocked.
2.	India Ink Fountain Pen and Non-Dulling Pencil	Non-clogging pen results in easier lettering. Pencil makes uniform line and needs no sharpening.
3.	Triangle Tester	Keeps triangles and T-squares accurate.
4.	Lighting	From 40 to 50 ft.-candles necessary.
5.	Adequate Pay For Draftsmen	What is his worth to the company?
6.	Air-Conditioned Drafting Room	A small investment gives a big increase in efficiency.
7.	Clean Drafting Tables	When was the last time they were resanded?
8.	Pictorial Drawings	This type of presentation saves time in the shop.
9.	Blueprint Room and Equipment	Adequate facilities. Make only white prints.

H. E. GRANT
Professor, Engineering Drawing, Washington University, St. Louis, Mo.

A SIMPLIFIED DRAWING may make sense for the few people who have the thorough training to understand it. But obviously this "short hand" method of engineering drawing cannot be used for the multitude. Two or three dollars saved in making a drawing is an immediate gain, but certainly this time saved in a drafting room is a false saving if it is more than offset by the difficulty encountered in reading this drawing in the shop. Furthermore, if this same print is read by a number of people, this time loss is multiplied. Over the lifetime of the average print, inability to read the drawing will lose many work hours. Thus, over the long term, money will be lost, and over-simplification ends in defeating its own purpose.

In collecting blueprints from industry for use in preparing drawing books, the author personally visited approximately 300 U.S., Canadian, and a few British concerns, selecting drawings from which prints were made. Thus, he has seen upwards of a half million drawings, with the majority of these tracings being in pencil. Less than 25 per cent of these were what one would call good pencil tracings; that is, tracings which could be easily read. In most instances it was a question of the lines not being readable, and then being burned out in the process of making the blueprint. If the tracing is underexposed, the result is a rainy blue. Inking, particularly the printing, would improve the quality of the blueprint. This process has been made simpler with a new inking fountain pen. However, many people feel that it is impossible to make corrections when the printing is in ink. The standard method of correction in this case is to cross out the old

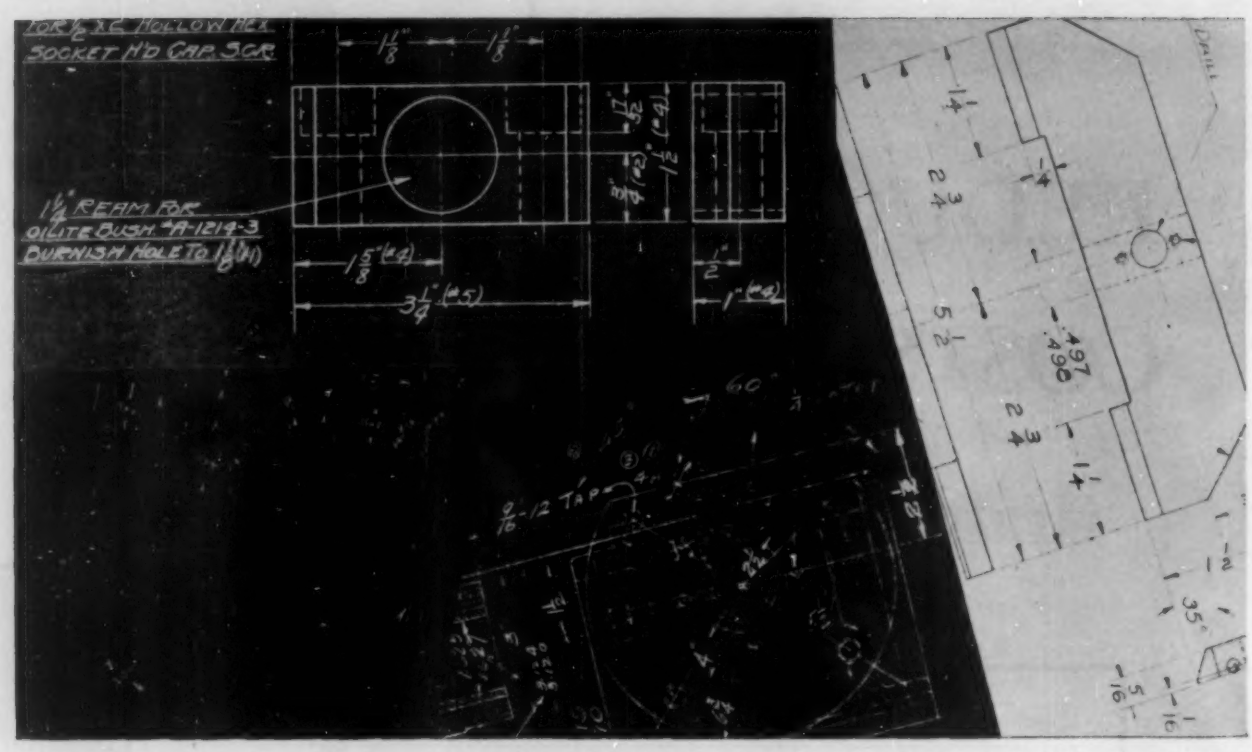


Fig. 1—The blueprint at lower left is an example of how light lines are burned out in the process of making the print. The one at lower right is slightly improved, but still difficult to read. The examples at top left and right show how prints should look if the drawing is made correctly with dark lines. A clear, readable blueprint will save much time and money in the shop.

figures and add the new figures right beside them.

Since the basic cause of poor pencil tracings is the incessant sharpening of pencils and the pressure of getting work done, industry should have insisted long ago that a pencil be developed which would never need sharpening. Such a pencil, the Faber Castell Lockite 9600, has been developed. Also, just announced by the Parker Pen Co. and Scripto, Inc. is a liquid lead pencil, which will not dull or break its point, and does not need resharpening. Parker Pen Co., confident of the new pencil's success, announced that the company has completely discontinued its manufacture of mechanical pencils and does not ever expect to produce another pencil with a breakable lead.

Industry has used for years the rigid big-bow center-adjusted screw compass. Consequently, the American prints usually have clearer reading circles than many European prints where this style of compass is not used. It was the author who suggested that the turning of the center screw, a time consuming job, be eliminated. The result is the German made Riefler quick-adjusting big bow compass, Fig. 2, which may be locked in position or unlocked in a second.

It is quite common to see triangular boxwood architects' scales being used in industry. Yet, this is the incorrect scale to use when working with most machine drawings. The correct scale is a Mechanical Engineers scale, which should be labeled as such. Just recently one of the larger manufacturers of mechanical drawing equipment announced a mechanical engineer's triangular boxwood scale. It should be this scale that the new graduate engineer brings from college to industry, and continues to use instead of the architect's scale. This new scale costs far less than the cost of one error in the shop caused by using an incorrect scale. It is common to find errors in measurements on industrial drawings.

With industry as the immediate beneficiary of such improvements in drafting equipment, it is industry's job to make these suggestions, and bring pressure to bear on the suppliers of drafting equipment.

A triangle tester, Fig. 3, is an easily made device which will benefit many. Even some new triangles are inaccurate, and if not, they will be in a few months, for the plastic used is not an inert material. The same is true of T-squares. Triangles, and T-square blades, or other plastic-edged blades must be assumed to be inaccurate unless they have been tested within the past six months. Inaccuracies with these implements produce errors in dimensioning and layout work. T-square blades can be corrected on a surface grinder, and similar errors on triangles can be corrected with a flat file.

Poor lighting causes eye strain which slows down work and causes errors. Although there has been much improvement in the past fifteen years, it is still not uncommon to see poor lighting in drafting rooms. All drafting rooms should have about 40-50 foot candles of light. **In addition, drafting rooms should be air-conditioned.** A draftsman must be expected to be even less efficient than the rest of the engineers since he must remain in one spot in hot humid weather. Assuming that the efficiency of one draftsman drops by one-third under these conditions, then the cost of an air-conditioning unit would be less than the time lost by two draftsmen for three months. For the average sized drafting room, a 5-ton unit would net a good return on the investment.

Drafting tables should be sanded periodically. It is not difficult, and a small portable sander will do the job. Besides, clean equipment psychologically produces better results.

The difference in pay between a good man and a poor man is small in comparison with the difference in the results obtained. Yet, this seems to be ignored to a considerable extent when it comes to draftsmen. If good results are expected of a good man, whether he is a draftsman, accountant, or salesman, it is expected that good salaries must be paid to hire him. However, draftsman's salaries are, as a general rule, considered low. Perhaps from this arises the stigma, or "dirty-word" connotation that the word "draftsman" carries. It is a position incorrectly looked down upon, and is regarded by some as "serving time" while waiting for a better job. A slight increase in the pay scale of a draftsman will increase twofold the value of the results obtained.

Pictorial drawing, especially in exploded assemblies, has been tried by many, with favorable results. An artist, adept at this type of drawing, could make many such sketches in a day's time for many draftsmen, in addition to adding such views to many blueprints. In the long run it will save much time and money in the shop where the machinist can see at a glance what the end product will look like.

Patternmakers and shop supervisors can offer many ideas. The author was amazed to learn from many of the plants that he visited, that neither the head patternmaker, nor the shop supervisors were consulted on the new designs developed in the engineering department. Those companies that did, listed numerous instances where these men saved thousands of dollars by their suggestions. Such men, when called in for consultation, will take pride in being asked into the engineering department, and will take more interest in the project. They know what the production problems are, and can cut costs by suggesting different design or short cuts. For example: a different design of a part which would permit an easier way of holding the part in the machine; or suggest a casting instead of machining.

Careless handling of tracings by the blueprint department will make the prints more difficult to read. Frequently, poor workmanship results because the job is considered as an interim job. In addition, the operator is given the worst place to work, and is often underpaid. Poor ventilation (if the ammonia process is used), inadequate shelf space and working area, all contribute to a bad job and bad prints. White prints are easier to read and should be used in the shop. Certainly if all newspapers, magazines, and books were blueprinted, there would be much less reading done.

Cooperation With Colleges

Some engineering colleges have suggested ways by which industry can help engineering students become better engineers. One way is for companies to contribute their reject parts to these technical schools so that the students may see the details of a part that they would not notice or visualize. These parts should feature threads, thread cutting tools of all sorts, milling cutters, reamers, and perhaps some small tools including special tools, springs, gears, non-circular gears, cams, gages, fasteners, and the like. In one plan of this nature, about three-hundred companies responded to his request, thus showing their willingness to cooperate with the schools, and their plans for producing better engineers. Such contributions may be made individually by companies through manufacturer's associations, chambers of commerce, or educational associations.

Many instructors, both in schools and colleges, lack the experience in industry that would make them better teachers. Summer employment in some companies would be of great assistance. In many instances, the companies that believe in this plan know that the instructors who get the part time work will be training many of the students soon to be hired by that particular company.

Boeing Airplane Co., for example, had been employing faculty members of engineering schools for summer work for some time, but it was not until 1951 that a formal program was set up. This Summer Faculty Program, as it is known, set up the following objectives:

1. To accomplish significant work assignments. This is the foremost objective, and is regarded as the real reason for the success of the program. Professors thus take on specific jobs, earn their pay, and learn more about their field and industry's needs.

2. To give the instructors a chance to learn the requirements which industry places on the graduate.

3. To acquaint the instructors with the industrial developments in their fields.

4. To give the employer a fresh approach to difficult, unsolved problems.

5. To provide beneficial relationships between the professors, the colleges, and industry.

6. To demonstrate the opportunities for the engineer-

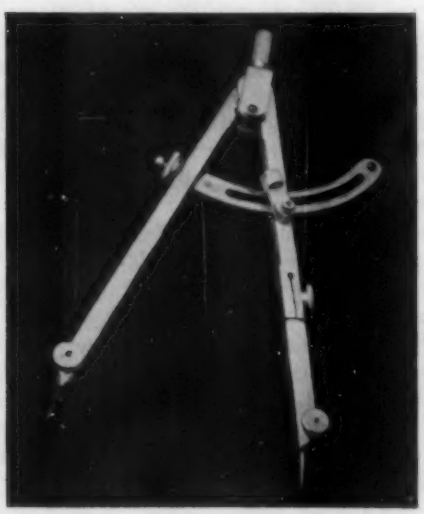


Fig. 2—An improvement in big-bow compasses, eliminating the center adjusting mechanism which took time to operate. The quick lock-unlock device, to change from large to small radii is shown on the right leg. The knurled wheel on the left leg permits fine adjustment, if necessary.

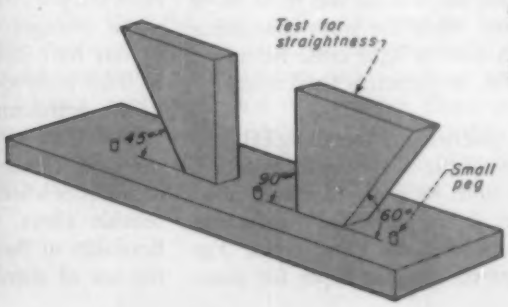


Fig. 3—Plastic triangles and edges of T-squares become bowed. Using this triangle tester, made from any smooth, plated stock, plus a smooth, flat file, any unevenness can be corrected.

ing graduate in the airplane industry.

Since 1951, from 50 to 75 full-time faculty members, picked from as many schools as possible in the nation, were offered these jobs for a minimum of two months each summer. Boeing's policy is to encourage former summer employees to get experience in other industries to broaden their background.

Just a few of the diversified assignments given to the summer professors last year were: electrical power analysis; radar test problems; measurement of residual stress in structural materials; rocket combustion chamber analysis; sheet metal layout; studies of magnetic servo and thermal problems; and many others.

A series of seminars and lecturers were arranged for one-hours sessions once a week. These seminars acquainted the professors with a broad knowledge of company operation; integrating the young engineer in industry; procurement of military and commercial business; and others.

Salary paid to these summer employees is based on the applicant's present teaching salary as computed on a nine months basis, plus an allowance for travel from his place of residence to Seattle, Washington.

Gains from such a plan are obvious. At the end of the summer the professors can apply the practical aspects of engineering in their classrooms, and counciling sessions with students. Boeing benefits by the latter when they receive engineers who already know the company's operation.

For ten years General Electric has been underwriting a six-week summer program for 200 high school science and mathematic instructors. Last year fifty chemistry and physics teachers were given advanced study at Union College in Schenectady, N. Y.; fifty graduate instructors took graduate work at Case Institute in Cleveland, Ohio; and two groups of fifty mathematics instructors studied at Rensselaer Polytechnic Institute in Troy, N. Y., and Purdue Univ. in Lafayette, Indiana. Each college selects its candidates, and General Electric pays all travel and living expenses, and places some of G.E.'s facilities at the disposal of the colleges. G.E. engineers, and executives lead field trips to many of their plants and laboratories.

Another General Electric summer program is to have about 25 of the nation's foremost professors of engineering spend five weeks visiting G.E. plants to find out what is new in their fields. Gaining of this up-to-date information by the professors can be passed on to their students, keeping them abreast of developments in industry.

Teacher training programs such as the ones mentioned here should not be limited to large companies alone. If each of our industrial concerns, small, medium, and large, were to employ just a few teachers for the summer, all would be employed in the fields where they would be learning instead of just earning. This learning would in turn produce better trained engineers. But here industry should take the initiative in setting up programs.

Stainless Steel Designations Changed

With improved industry practices, the elimination of government controls, plus an effort to get a wider degree of flexibility in working stainless steel, the American Iron and Steel Institute has just announced new designations for stainless steel types. The result is an even greater uniformity and dependability in these special requirement steels. New additions to the 300 and 400 series bring the total of standard designations to 35. Changes also have been made in the published analyses for the 501 and 502 heat resisting steels which are grouped with, but not classified as stainless.

The last change in published designations was made in August 1952, mainly to comply with NPA orders to restrict the use of critical alloys. When these restrictions were lifted, steelmakers returned to the pre-Korean analyses.

Machinability—Much attention was given to machinability, in the new standards, with the establishment of three new types—303Se, 416Se, and 430F Se. So, in effect, the designers and fabricators are now offered a choice of getting high machinability with the additions of sulphur or selenium. Stainless steels containing sulphur are said to be more suitable for deep or heavy cuts, while the types containing selenium are preferred for shallow or light cuts. Selenium also is reported to be helpful in reducing tendencies for seizing and galling.

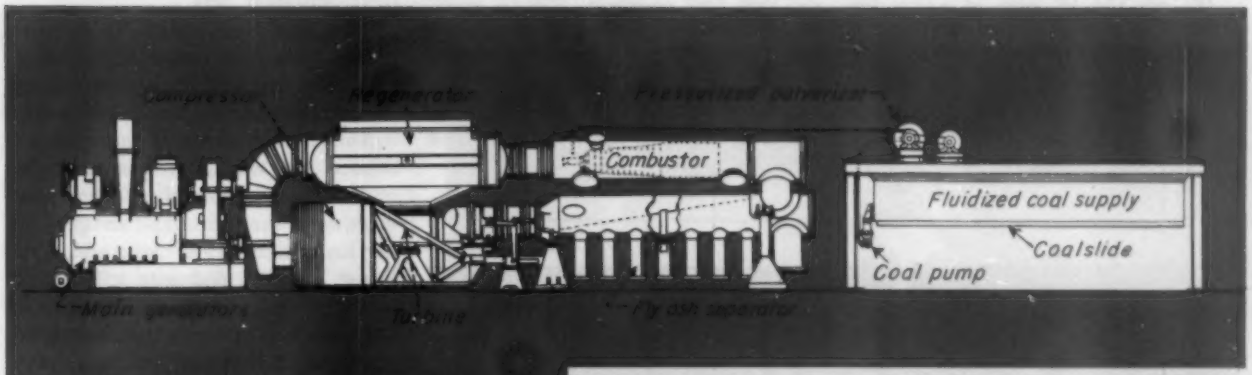
Improvements in melting practice and metallurgical control are responsible for many of the analyses changes. Because producers have been able to work to closer alloy limits, particularly on carbon, it has permitted a reduction in the maximum formerly specified for some types. For example, low carbon is required in most types for maximum resistance to corrosion, while higher carbon is needed for increased hardness, as in cutlery grades. The six types that have been changed in the maximum allowable carbon content provided for by standard compositions are: 301, 302, 302B, 316, 317, and 446.

With the removal of government restrictions on the alloys used in making stainless steels, all "TS", or Tentative Standard types have been eliminated. These types were TS 316, TS 347, and TS 347A. For example: TS 316 was established for the conservation of molybdenum. However, the industry is presently producing 316 and 316L which provide higher molybdenum contents, and, increased corrosion resistance for certain applications. TS 347 and 347A were set up to conserve the use of strategic columbium resources.

Types 301, 302, 302B—Type 301, used in the transportation industry, and type 302, the most widely used of the chrome-nickel stainless steels, have been modified in carbon-content. Type 302B for high temperature service has also been modified. Carbon content for each has been reduced from 0.08/0.20 to 0.15 maximum. These are a few of the major changes in the standard types of stainless steel. Others have been reported, such as the addition of 0.45 to 0.60 molybdenum to types 501 and 502, used mostly in the petroleum industry, and conforms with practice.

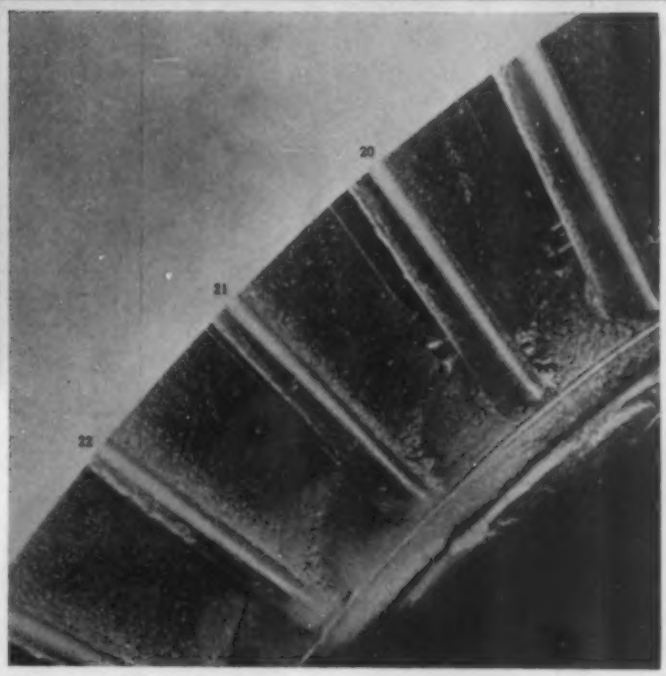
The Iron and Steel Institute feels that on the whole, the new changes reflect significant advances in melting techniques which will give the designer and consumer more reliable alloys. The new modifications will give greater flexibility in the use of each type, and will help to expand the use of stainless steels.

TECHNICAL NEWS



EXPERIMENTAL RAILROAD LOCOMOTIVE gas turbine power plant with fluidized coal supply and pressurized pulverizer. Thermal efficiency: 26.8 per cent. Rotary pump at right feeds coal from tank to pulverizer and compressed air line which leads to twin combustors.

THE FIRST ROW OF STATOR BLADING photographed after operating for 743 coal hours. There is no measureable erosion, nor any ash deposits. Blade material is 19-9-DL, a chromium-nickel alloy. Maximum operating conditions were 5400 rpm and 1250 F turbine inlet temp.



Coal Industry Fights Back With Gas Turbine

Hoping to regain some of railroad business (100-million tons a year) taken by the diesel locomotive, coal producers are looking with interest at the results of a successful experiment with a coal-burning gas turbine power plant developed for railroad use. Interested too, are cost concious railroad operators who stand to save better than $40,000 on fuel a year per locomotive by switching back to coal operation when their diesel units wear out.

The coal-burning gas turbine program was started in 1945 as a cooperative project by the Locomotive Development Committee of the Bituminous Coal Research, Inc., and the American Locomotive Company. The railroads and coal industry have backed this project heavily from the financial standpoint. In the final test and development stage from Jan. 1953 to April of this year, the work was divided into three parts:

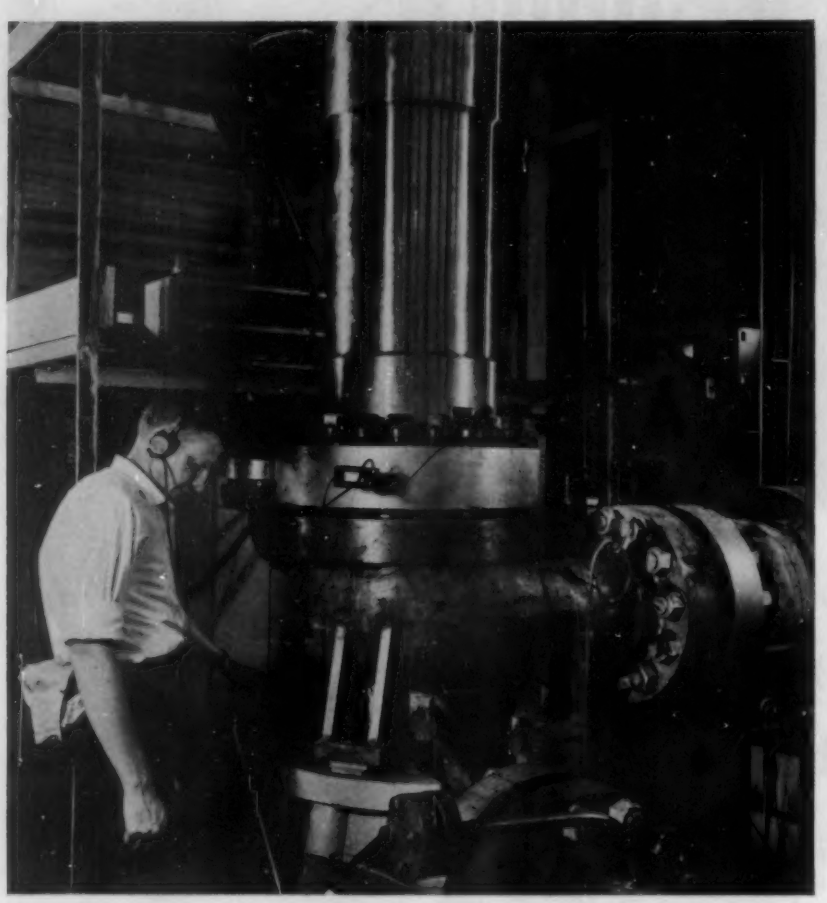
1. Develop a suitable pneumatic coal handling equipment so that a coal-burning gas turbine locomotive will be able to carry its fuel in underframe tanks similar to oil tanks. The fine coal used is in the $\frac{3}{8}$ to $\frac{1}{8}$ x 0 size range before going through the pulverizer. The price of coal in these sizes is much less than the lump coal used in the steam locomotives. Fine coal is 15 cents per million Btu's; lump coal is 22 cents; and diesel fuel is more than 80 cents per million Btu's.

2. Design and build an improved fly ash separator. During the first 300 hours test, the results of the new separator were good. In this 300-hour test run, power generated totaled 545,000 hp hr, giving an average load of 1,815 shaft hp, and a specific fuel consumption of 1.33 lb. per hp. hour. The average inlet temperature was 1060 F, and rpm was 4500. The overall thermal efficiency for the test was 14.2 per cent, which was consistent with the low inlet temperature and the absence of the regenerator. Ash entering the turbine averaged less than one per cent above 10 microns and 9 per cent about 20 microns (which is about one thousandth of an inch) in diameter.

The only difficulty encountered was the plugging of the separator blowdown lines. At the end of the 300

hr test, there were no ash deposits on the blades, and no erosion, as is shown on previous page.

In the 433 hr tests in 1955, the regenerator was returned to the system, the coal preparation system was improved upon, rpm was increased to 5400, and inlet temperature increased to 1,250 F (max. for the material used in the blades). At these conditions with 80 F inlet air, the rated power of the plant was 3,540 hp. Results of these tests, including 50 hours at 102 per cent load factor, showed no measureable erosion or ash deposits on the blades, no ash deposits on the regenerator tubes, and an average specific coal rate of below one pound per hp hour, giving a thermal efficiency of 20.8 per cent.



The Problems in Nuclear Engineering

A general breakdown of the funds spent in nuclear engineering over a number of years on projects like the development of the submarine thermal reactor give a rough idea as to the type of problems that were encountered. About 36.8 per cent went into metallurgy and metallurgical engineering; 28.1 per cent for mechanical engineering, including heat transfer; 11.3 per cent went into electric and electronic engineering development; 11.2 per cent for theoretical and experimental physics work; 6.9 per cent for chemistry and chemical engineering; and 5.7 per cent for operational engineering and testing.

One such problem was the design of a centrifugal pump (above) for the primary coolant system. Designed by Westinghouse Electric Corp., this pump circulates the radio-active primary water through the reactor vessel when it is heated to a high temperature, then pumped through the steam generator where it transfers the heat to secondery water circulating through tubes. The resultant steam is sent to the main propulsion turbine and the turbo-generator sets.

The pump is driven by a three phase induction canned-motor unit, absorbing full system pressure across the Inconel stator can. Within the motor, cooled primary water is circulated an auxiliary radial-vane impeller. From here the water flows downward through the "air gap" to the lower radial and upper and lower thrust bearings, and into the cooling tubes of the heat exchanger. The water then returns to the top of the pump where it enters the motor frame and the auxiliary impeller suction. Some water from the auxiliary impeller is bypassed from this circuit to circulate water to the upper radial bearing. The bypassed water flows through the bearing, then directly back to the auxiliary impeller suction.

Motor heat is carried off to the primary water being recirculated within the pump. A close-fitting labyrinth type seal on the shaft just below the thrust bearing and a double Belleville spring arrangement prevent the motor cooling water from circulating with the high-temperature primary coolant water.

Silicone-Rubber Insulation For Large Motors

The first all-Silicone-Rubber insulation for large motors and generators has been announced by The Allis-Chalmers Mfg. Co., for use on all class H insulated form wound coils, and for Class A and B windings operating under certain service conditions.

Allis-Chalmers claims that the development will change motor application practice in many industries, and that it takes engineers closer to the goal of the perfect insulation—that is, one that would never deteriorate or change in dielectric or mechanical properties, regardless of load.

Properties of Silco-Flex: Dielectric and Mechanical properties do not change at temperatures up to 480F; water absorption is insignificant under most extreme conditions; cooler operation from the high thermal conductivity of Silicone rubber; Abrasion resistance far better than conventionally insulated coils.

Setting Type Photographically

The mechanical production costs of newspaper publishing have risen sharply in recent years, with the make-up of advertisements taking the greatest part of this increase. Looking for an out, while still giving service to the advertiser and public, publishers attending the recent American Newspaper Publishers Association meeting in New York were quite receptive to the claims of Photon, Inc., manufacturers of a new machine which sets type photographically. Photon, who expects to lease the machines for $400-$600 per month, claims that the response was excellent to their offering of the machine at this price.

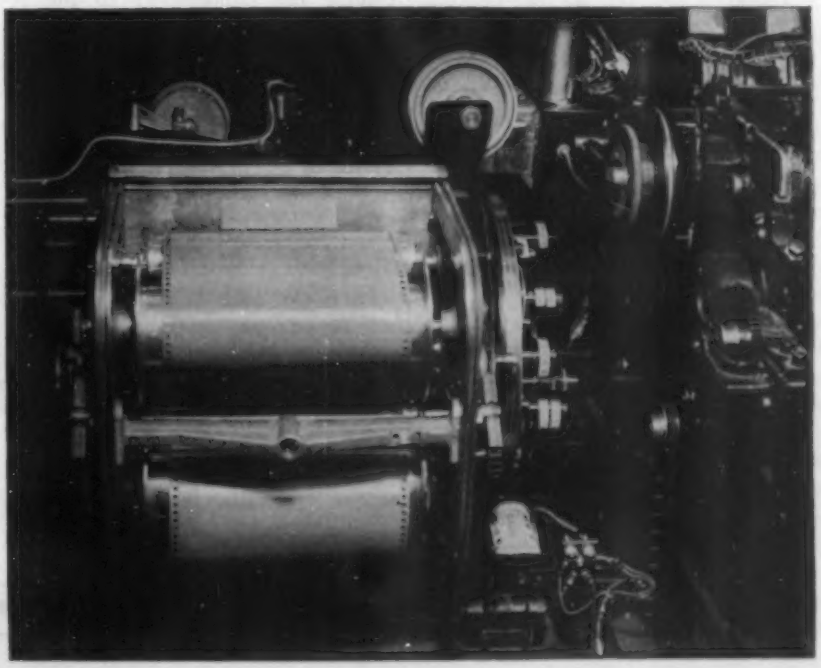
The theory of the Photon was conceived by two French inventors, Rene Higonnet and Louis Moyroud, and further developed by the Graphic Arts Research Foundation, Cambridge, Mass. Announced about two years ago, the machine is being used for the composition of the editorial page of one newspaper, and the Photon has been used for the typesetting of several books.

Basically, the operation is this: The typist sits at a conventional typewriter keyboard and types a manuscript which is reproduced in two places—one, on the paper before him, and second in a memory or storage system just behind the typewriter. The paper copy serves as a record, and also tells the operator if he made a typing error. If a mistake is made, the typist moves the carriage back to the incorrect letter, pushes a correction key, which erases it from the memory device, and then types the correct letter. There is a similar correction key which erases an entire line.

He may type more letters. If the line is over-set by one letter, the keyboard locks, and the operator must backspace to erase the extra letters. After the line has been corrected, the operator presses the carriage return key. The machine then computes the justification, which is the correct spacing between words, or letters and words if necessary, so that the line will appear on film with an even righthand margin.

Next, the decode and control unit

THE PHOTOTYPESETTING MACHINE ready for work. Center keyboard is that of a standard typewriter, with an additional row of keys along the top. Knobs at left are for selecting the space between lines, and line width control, plus a conversion table for line width. Keyboard at right is for selecting a particular type face from the 16 faces listed. Size of letter is also determined here, as is the spacing of letters and words.



UPPER RIGHT is the glass disk which holds approximately 1400 characters and symbols, including 16 complete alphabets of type. Beside it, to the left, is the lens turret system which carries 12 lenses to give the proper type sizes. The glass disk, 8 in. dia., revolves continuously, and a stroboscopic light passes through the selected letter to be printed into the lens system, which projects it on the film at left.

automatically operates the photographic unit which exposes the letter characters and spaces them on a sensitized film. The end product of the machine is a photographic positive or negative film showing lines of type. This film can be arranged at will in "laying out" the page, and nothing gets to the expensive metal type stage until the layout is agreed upon, and all mistakes are corrected. Then, the film page is exposed to an offset plate for letterpress printing, or to a sensitized magnesium plate.

The photographic portion of the machine incorporates a glass type wheel 8 in. in dia and $\frac{1}{8}$ in. thick, which carries the type characters. The disk holds 16 complete alphabets of type, plus some special characters and symbols, totaling about 1,408 individual characters. The side of the disk carrying the characters is mounted towards the film upon which the exposures are to be made. In operation, a stroboscopic lamp passes light through the selected character on the disk into an optical system which projects the light in the form of a type character on the sensitized film. The disk revolves continuously 8 rev./sec., but the type image is stopped on the film by the stroboscopic light.

Other controls on the keyboard permit the selection of: (1) style of type (the word "photocomposition" for example, could be printed like this

PHOTOCOMPOSITION

just by touching a particular key before each letter is typed); (2) 12 point size to be used from 5 to 36 pt. (6 pt. equals 1 in.); (3) desired line length (up to 7 in.); (4) space between lines (from $\frac{1}{2}$ pt. up); (5) correction of individual character errors; (6) elimination of a complete line; (7) automatic centering, or flush right, or flush left; (8) and insertion of fixed spaces of varying width.

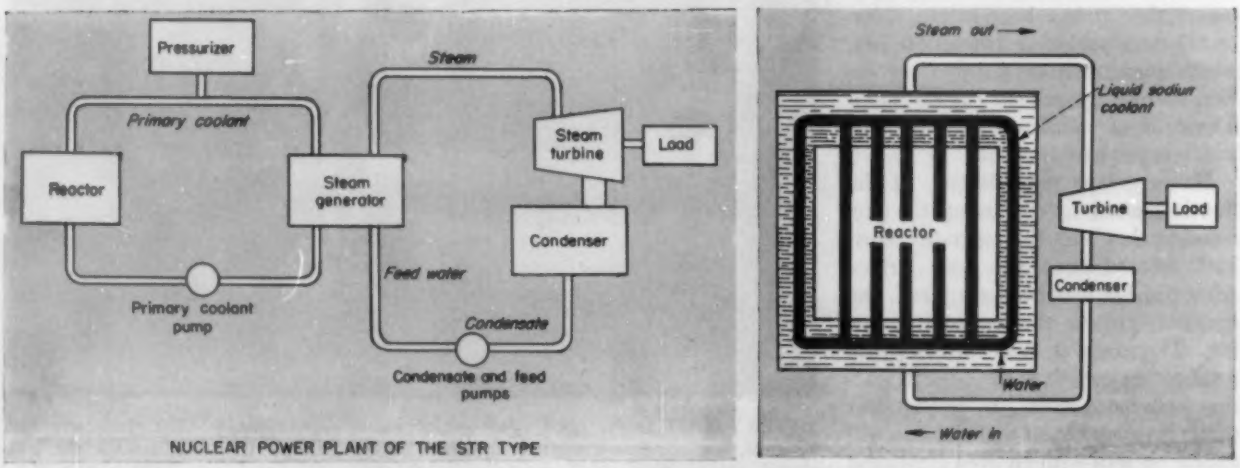
New Reactor Design Cuts Weight by One-Half

A big step forward towards the use of atomic power plants for airplanes, locomotives, and ships has been made by General Electric Corp. with their proposal for a new atomic reactor design. The design is said to more than half the weight per horsepower of "conventional" atomic reactors, and eliminate many moving parts that are standard in such equipment.

Designed by Dr. E. A. Luebke, physicist, and L. B. Vandenburg, engineer, of the Knolls Atomic Power Lab. in Schenectady, N. Y., operated by G. E. for the Atomic Energy Commission, one of the two features to the huge weight reduction is the nesting of the reactor inside a cylindrical heat exchanger which uses liquid sodium as a coolant. This arrangement not only does away with the separate heat exchanger used to change water to steam to drive the turbines, but it eliminates much of the piping, valves and open space which must be shielded to protect against radiation. Furthermore, the heat exchanger wrapped around the reactor helps to confine the radioactivity to the reactor.

The second feature is the use of the electricity generated by temperature differences in the heat exchanger. The two scientists at G. E. figure that this source of power can be used directly to pump the liquid metal coolant. In effect, the system provides its own power for pumping without taking any of the energy from the main turbine.

The pumping action is obtained from the generating of an electric current in the heat exchanger by the temperature gradient normally existing between the hot and cold tubes, then adding the necessary crossed magnetic field with iron pole pieces to produce a sufficient force on the liquid metal. Also, the pumping action on the liquid metal is self-regulating. An increase in reactor power resulting in a rise in sodium temperature will cause increased pumping action. With an increased demand from the tur-



SCHEMATIC DIAGRAMS (left) of the STR (Submarine Thermal Reactor), the power plant used in the new submarine Nautilus, and (right) what G.E.'s new reactor might look like as a result of nesting it inside a cylindrical heat exchanger.

bine, the temperature gradient is increased, causing increased pumping.

If more control of the liquid movement is necessary, an electrical resistance device operating somewhat like a reactor control rod can be used. But the voltage amounts are so small that a thin layer of insulating material can reduce the current moving through the heat exchanger. The important point is that this pumping method has eliminated coolant pumps and its insulation problems.

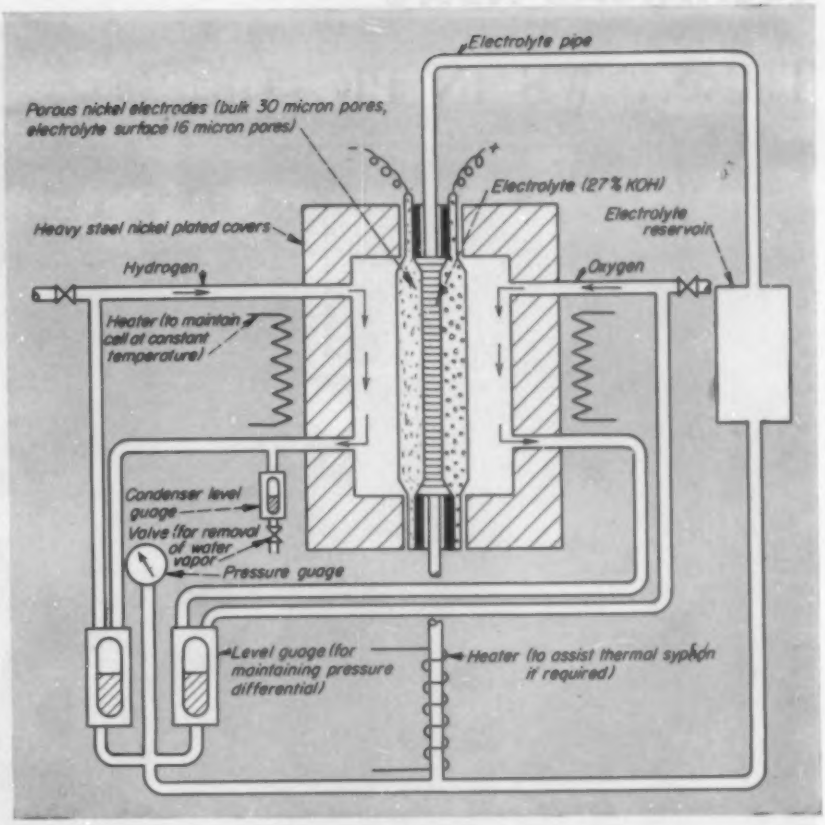
AEC security at General Electric prevents any further information from released as to the type of fuel to be used (uranium or plutonium), and what its power might be in comparison to other types. General Electric is presently working on the reactor which will power the Navy's second atomic submarine, the Sea Wolf. This reactor also will use liquid sodium as a coolant. The reactor in the Nautilus uses water as a coolant.

New Coating for Magnesium

Under sponsorship of the Army, the National Bureau of Standards, Washington 25, D. C., has developed a low-voltage alkaline chromate process for depositing protective coatings on magnesium alloys. While the coatings produced are equivalent or slightly better in corrosion resistance coatings, NBS feels that their process is potentially more economical than other methods, since it uses a low-voltage power supply and only two chemical constituents other than water.

The NBS process is similar to electroplating except that a-c is used instead of d-c, and the coating is formed on both electrodes. Some material is deposited out of the solution onto the electrodes in the anodizing process, but the coating is mainly material formed by the chemical reaction between the metallic electrode and the components of the electrolyte.

The process differs from the acid chromate and the HAE anodizing process in two respects: (1) it operates at a lower voltage—about 10-12 volts a-c; and (2) the electrolytic bath contains only sodium or potassium hydroxide and the corresponding chromate. A current of 80 to 140 amp/ft^2 is passed through the bath 20 to 40 min. at 150-170 F. Under these conditions, a coating 1 to 2 mils thick will form on the magnesium electrodes.


Electrolyte pipe
Porous nickel electrodes (bulk 30 micron pores, electrolyte surface 16 micron pores)
Electrolyte (27% KOH)
Electrolyte reservoir
Heavy steel nickel plated covers
Hydrogen
Oxygen
Heater (to maintain cell at constant temperature)
Condenser level guage
Valve (for removal of water vapor)
Pressure guage
Level guage (for maintaining pressure differential)
Heater (to assist thermal syphon if required)

Fuel Cells for Portable Power

Financed by the British Electrical and Allied Industries Research Association (ERA) and the Ministry of Fuel and Power, plans are being made to set up a prototype oxygen-hydrogen fuel cell with a minimum rated output of 2-3 kw, and a guaranteed life of over 1,000 hours. Using hydrogen and oxygen, and exhausting water, it will produce electricity directly. Although such a flexible, portable power source might first be used for electric trains, heavy electric power consumers and producers are also interested.

If the project is successful, the British Transport Commission could use the fuel cells to equalize the rush-hour demand and slack periods, and extend the range of its electric trains beyond present limits of high-tension lines.

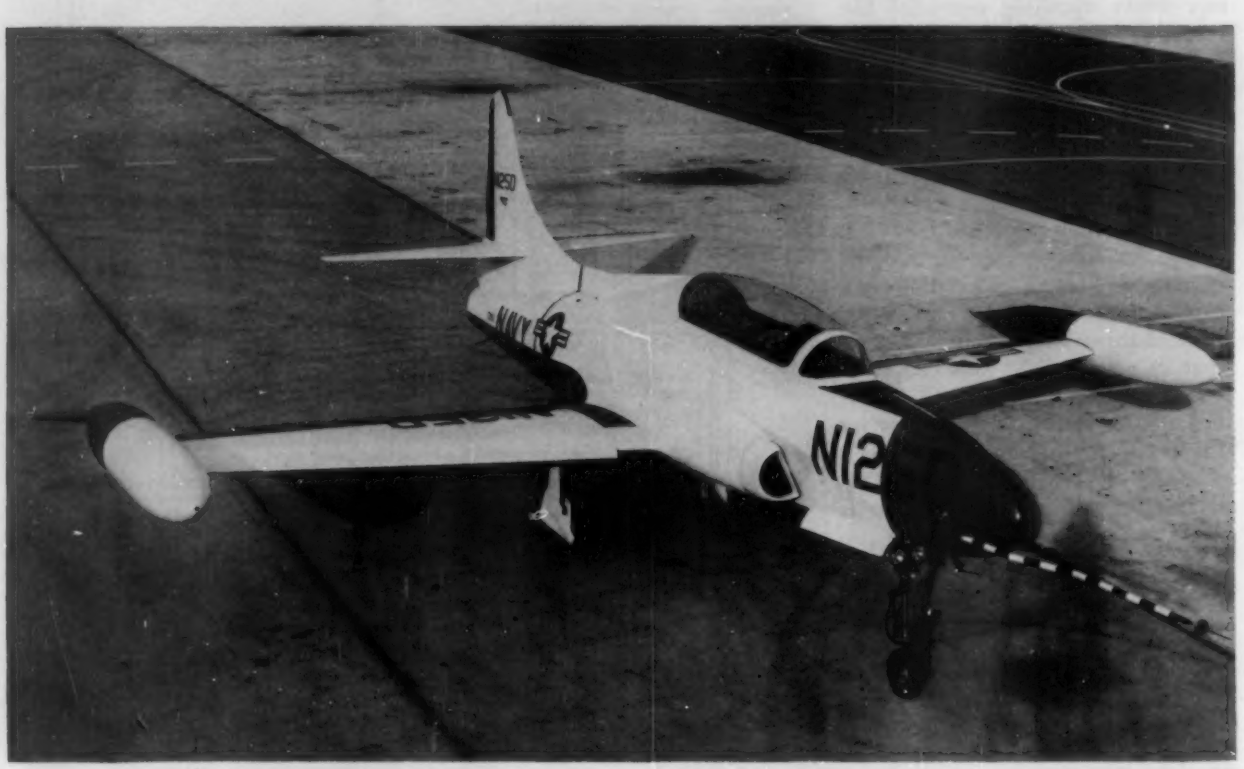
Designed by F. T. Bacon of Cambridge Univ., the laboratory cell is a short cylinder with an internal diameter of 5 inches. Inside the two halves of this cylinder, and centered between them are two porous nickel electrodes $\frac{3}{32}$ in. thick and $\frac{1}{16}$ in. apart.

A 27 per cent potassium hydroxide aqueous electrolyte circulates between the electrodes. In the spaces between the electrodes and the nickel-plated ends of the cell, gases circulate—O on the plus side, and H on the negative.

The cell operates at between 140 C and 240 C, at a pressure of 600 to 800 psi. A small positive pressure of about 1.5 psi is maintained in the gas chambers to prevent the electrolyte from entering the electrodes further than the thin layer of the small pores. The reaction takes place along the thin surface where the gas and electrolyte are in contact. A thermal syphon circulates the electrolyte. Except for the electrolyte's lines, almost all piping runs cold.

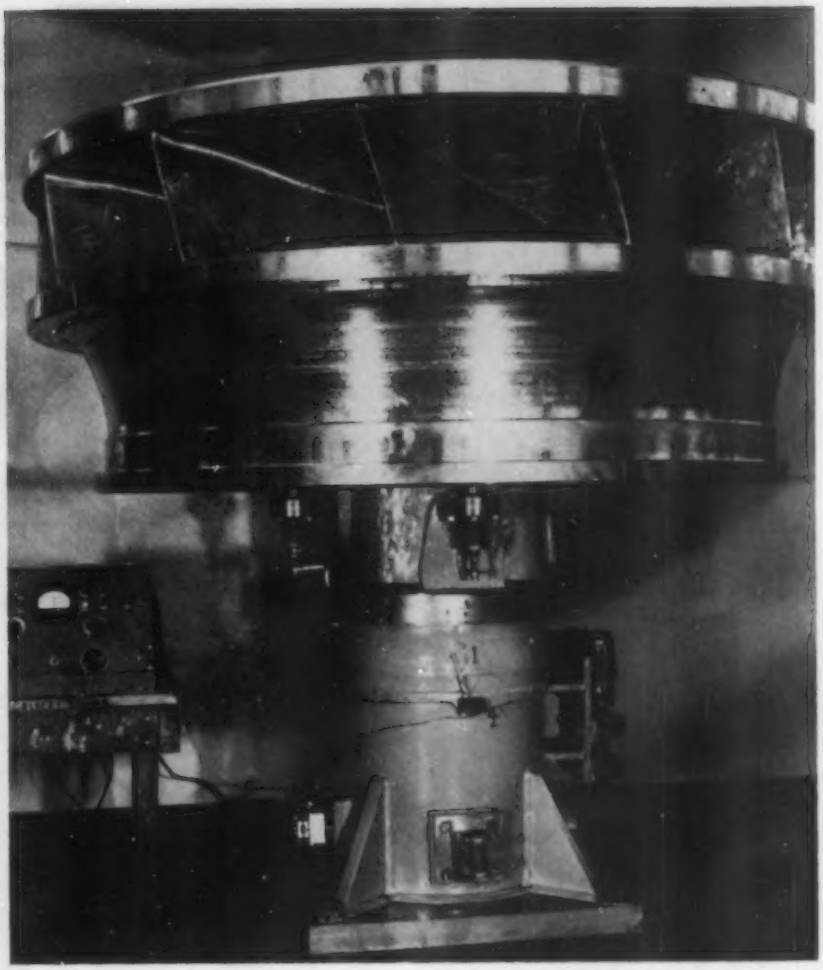
In the prototype unit, Bacon expects to increase the dia. of the cell to 10 inches. Using 100 of these cells in series would jump the amperage to 100 amp. at 0.8 volts, operating at 200 C, and giving a total capacity of about 8 kw. An advantage of this unit over the lead batteries now used in some railroad engine is that the O-H cells will have a weight of 50 lb./kwh stored compared to the 85 lb./kwh stored for lead batteries.

THE NEWS IN PICTURES

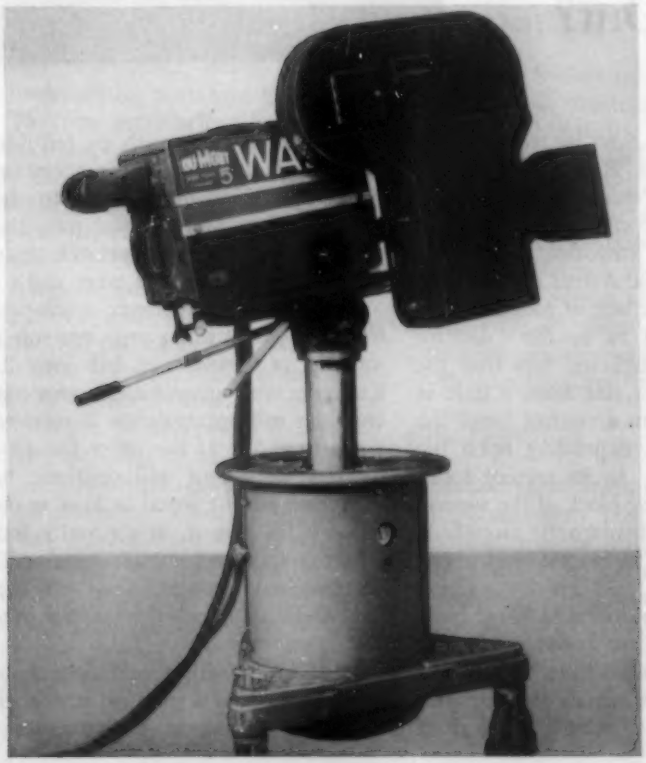


THE T2V-1, THE NAVY'S FIRST TWO-SEATER JET TRAINER designed to operate from aircraft carriers, can perform all the maneuvers of a standard fighter at 600 mph, yet has a landing speed of 97 mph. Made by Lockheed Aircraft, the trainer is the first plane put into production equipped with a boundary layer control system as standard equipment. With this system, high compressed air from the engine is diverted into a tube which runs inside the trailing edge of the wing, and then blown through small holes over the wing flap and ailleron. This effect tends to make the normal flow of air over the wing hug the skin surface, giving the plane greater lift and anti-stall characteristics. Movable slats on the leading edge increase low-speed stability. With new "two-in-one" instruments, the pilot can, by flipping switches, use one gauge to get various readings.

UP TO EIGHT HOURS of uninterrupted playing time is possible with a new invention which combines the principles of both tape and disk recording, yet, without the disadvantages of both. In the illustration, what appear to be books on a music cabinet are in reality plastic containers holding pure vinylite tape with about 82 grooves on the ¼ in. band. To play one of the sound books, a plastic window on the curved end of the container is slid back and the exposed soundband extended in a loop. The container is then placed on the driving spindle and the loop placed around the playing wheel. The needle, mounted in the housing at right, is then pressed against the tape. In play, the band, which is about 950 ft. long for a 4 hour play, is fastened at both ends and rewinds automatically. The scale in front permits the selection of any specific tune. The device was developed by Tefifon Co. of Germany. U. S. distributor is Audio-Master Corp., 17 East 45 St., New York, N. Y.



A TURBINE RUNNER weighing 7,500 lb. and with an outside diameter of 5 ft., was balanced to 1.2 in.-lb. using a small dynamic balancing machine which can be mounted on the shop floor or on the table of a large vertical mill. Made by the Pelton Water Wheel Co., 2929 19th St., San Francisco, Cal., and available in three sizes with maximum capacities of 10,000, 100,000 and 250,000 lb., the balancer consists essentially of a heavy support frame which carries a turntable whose rotation can be varied between 10 and 20 rpm. The turntable is carried on a weighing shaft supported by heavy anti-friction bearings. The weighing shaft is positioned on the lower end by four roller assemblies, two of which are fixed and two preloaded by compression springs. Unbalanced forces are transmitted by the weighing shaft through the roller assemblies to leaf springs, and to the strain gage element of the electronic amplifier. Big advantage of the balancer is that the turntable is in a horizontal position with only an adapter plate necessary to set the piece on the balancer. Also, handling expenses are reduced if the piece can be balanced while on the mill table.



STRAPPED ON A CONVENTIONAL TELEVISION CAMERA is DuMont's Electronican, a new television-film system which will photograph on high quality film a program which is simultaneously being telecast. The film is removed from each of the cameras used for the program and sent to a developing center where it is cut and edited according to a copy made of the final telecast. The film is then printed and processed for use on theatre screens, or delayed broadcasts. Although the camera is attached to the television unit, a common lens system is used. Light passing through the lens system is split into two parts—one to the film and one to the pickup tube of the unit's television section. The focus control is attached to the common lens system. DuMont Labs., Inc., 750 Bloomfield Ave., Clifton, N. J., feels that the advantages of the new film system are: better quality film than with the electronic black-and-white recording systems, (color films can be made); speed with which the films can be made cut production costs; with quick film service to outlying stations, expensive microwave and coaxial cable facilities will be eliminated. At present, ⅓ of all programming is on film, with the proportion growing.

BASIC BUILDING BLOCKS of the new Westinghouse system are transistors and magnetic amplifiers. With magnetic amplifiers, the unit at right is about 5 in. square and one-half in. thick. With no moving parts, the unit's operating life well exceeds that of a relay. Unit at left is made from transistors.

THE CONTROL SYSTEM for an automatic bus duct welder, with the original relay control panel below and the Cypak System which it replaces, above. This is a simple automatic control with facilities for the positioning and welding of a piece of work, and the necessary, starting, stopping, and interlocking features. Setup has many of the problems of complex controls. Bank of switches in the center permit the transfer of control from one system to the other.

The Relay: On Its Way Out?

The main attraction at the recent Westinghouse 19th Annual Machine Tool Electrification Forum was their Cypak systems—new control components with no moving parts. For information processing—not power handling—these systems are designed for an 18 volt a-c supply. The system incorporates four basic units which in combination can perform any function in an automatic control system now handled by relays.

Westinghouse feels that the automatic manufacturing operation will arrive eventually; but it will not be successful if the control systems are based on present complex relay control arrangements, which are large, difficult to maintain, and expensive.

The new systems are static switching circuits developed for industrial control applications. They are not direct replacements for relays on a one-for-one-basis. Rather, they will be used as a replacement for a relay system. The basic components are special magnetic amplifiers and transistors, giving the system a built-in reliability with its lack of moving parts.

Also referred to as the "director system," Westinghouse says that the system ranges in size from a unit as big as a table, to a control panel the size of a piano, depending upon the job it must do. In its present form, the basic building block of the system, when made with magnetic amplifiers, is flat, about 5 in. square, and about ½ in. thick.

Functions performed by these basic building blocks are known as "and", "or", "not", and "time" functions. The "and" unit signals the performance of an operation only when all of a given number of signals are fed into it. Example: in a machining operation requiring three dimensions to be checked, the "and" would pass the part along to the next operation only if the other dimensions were met.

The "or" unit delivers a job-performing signal when any one of a number of signals are fed into it. Example: an automatic elevator on one floor will operate when it receives a call from any of the other floors.

The "not" unit will continue to deliver an output signal as long as no signal is fed into it. If a signal is fed into the unit, no output signal will be delivered. Example: an electric lock which stays locked while the current is on.

The "time" unit would deliver or delay a signal for a specified period of time. It is nothing more than a mem-

ory which retains a job-performing signal until another signal erases it.

The speed of response of the new system is also a plus factor. Transitors operate in a hundredth of a millisecond, and can be made to operate faster. At best, relays need about 10 milliseconds. Magnetic elements operate easily in one millisecond where necessary. On the average, the speed of response of transistors is better than magnetic elements by a factor of 100; and magnetic elements are better than relays by a factor of 10 or more.

Polyethylene Expands its Uses

An improved polyethylene plastic, which, among other things, can be steam-cooked without losing shape, cooled to −78 F and take impact tests of 32 ft.-lb. without breaking, has been announced by Koppers Co., Inc., Pittsburgh 19, Pa. Trade-named Super Dylan polyethylene, the new material is said to have many applications where ordinary polyethylene cannot be used.

These are: for molding into housewares which can stand up under steam sterilization; in aircraft, because of its low temperature strength; molding of toys; extrusion of plastic pipe which will withstand higher pressures and greater temperature variations (as a pipe, it has held pressures as high as 1,000 psi). Other uses suggested were: washing machine agitators; automobile steering wheels, which will have less danger of breakage; heater fans; and air conditioning parts and housings.

The new polyethylene has a better surface appearance in molded parts, and can be colored easily. It is machinable, has a less waxy surface than regular polyethylene and is acid resistant.

Range of properties: Specific gravity, 0.93–0.95; Tensile Strength, 2800-5500 psi; Elongation in tension, 400-1000 per cent; Stiffness modulus, 50,000-100,000; Impact Strength (unnotched Izod at −85F), over 32 ft./lb./in.; Tear Strength, 600-1300 lb./in.; Hardness (Shore D Scale), 63-70; Dielectric Constant (80 megacycles), 2.2-2.3.

Koppers is now producing the new plastic in small quantities, but plans to step up production this fall.

Coming Events

JUNE 19-23

Semi-Annual Meeting, American Society of Mechanical Engineers, Hotel Statler, Boston, Mass.

JUNE 20-24

American Society for Engineering Education, 63rd Annual Meeting, Pennsylvania State Univ., University Park, Pa. Sessions will be on: Selection and guidance of High School students for engineering training; Engineering education abroad; Relations with Industry. Sec. of Defense, Charles E. Wilson will deliver the major address at the banquet on June 23rd. For information, write to Prof. K. L. Holderman, 103 Mechanical Engineering Bldg., Penn State Univ., University Park, Pa.

JUNE 23-25

Heat Transfer & Fluid Mechanics Institute, Los Angeles Campus of the Univ. of California. Will present the latest advances in fluid mechanics, heat transfer, and related fields. Participating colleges are: Cal. Institute of Technology; Stanford Univ., Univ. of Santa Clara; and Univ. of Southern California. All papers will be preprinted in full. For more information contact: Mr. Tribus, Dept. of Engineering Extension, Univ. of California, Los Angeles 24, Cal.

JUNE 25-JULY 1

American Society for Testing Materials, Annual Meeting, Chalfonte-Haddon Hall, Atlantic City, N. J. A number of papers will be presented at the following symposiums: Speed of Testing of Non-Metallic Materials; Impact Testing; Atmospheric Corrosion of non-ferrous metals; Metallic Materials for Service at Temperatures about 1600 F; High Purity Water Corrosion; sessions on Fatigue; Effect of Temperature; and others.

AUG. 15-AUG. 26

Massachusetts Institute of Technology, Cambridge 39, Mass. Special two-week summer program on Noise Reduction. This year's program will be directed to the man who has a noise problem. Topics will include: behavior of sound waves; decibels, sound pressure level, sound power level, and intensity level; quieting of engines; integrated noise control problems; and others. Contact: Summer Session Office, Room 7-103, Mass. Institute of Technology, Cambridge 39, Mass.

AUG. 22-23

"Electronics and Automatic Production," sponsored by the National Industrial Conference Board and The Stanford Research Institute, San Francisco, Calif. It will precede the annual Western Electronic Show and Convention scheduled there for the same week. Discussion will cover: Management considerations of capital and plant requirements; Production control and marketing; How automation may be expected to affect the electronics, machine tool and material handling industries; Quality control and personnel requirements; Factors influencing product design; and many others. For more information write to: National Conference Board, 247 Park Ave., N. Y., or the Stanford Research Institute, Palo Alto, Calif.

AUG. 24-26

Western Electronic Show and Convention, San Francisco, Calif. The show will be held at the Civic Auditorium, with Convention Headquarters at the Fairmont Hotel. For full particulars contact: Mal Mobley, Jr., WESCON, 344 N. La Brea Ave., Los Angeles 36, Calif.

SEPT. 6-17

National Machine Tool Show, the Production Engineering Show, and the Metalworking Machinery and Equipment Exposition, Chicago, Ill. Held simultaneously, the Machine Tool Show will be in the International Amphitheatre, the Production Engineering Show on the Navy Pier, and the Metalworking Machinery Exposition at the Chicago Coliseum. Shuttle busses will run from the Loop area to the shows, and between the two shows. Exhibits at the Machine Tool Show will be confined strictly to machine tools. At the Production Engineering Show, some of the exhibits will be electronic devices, air gauges, conveyors, brakes, clutches, and drive mechanisms, weighing equipment, lubricating systems, and others.

FINANCIAL AID TO HIGHER EDUCATION

Business Help for Our Colleges A Job for All Business Firms

IN recent months, individual business firms have announced the adoption of a variety of plans, both imposing and ingenious, for financial aid to higher education in the United States. In doing so, they have taken a lead in dealing with a problem of transcendent importance both to the business community and to our nation as a whole.

Previous editorials in this special series have shown that:

1. Our colleges and universities, and particularly the independent, privately endowed institutions, are in grave financial difficulties.
2. These difficulties promise to become much more acute in the years immediately ahead unless extraordinary steps are taken to relieve them.
3. A financially crippled system of higher education is a major national menace.

If, however, the business community is to play an adequate part in helping our colleges and universities financially, the plans adopted by business firms thus far constitute merely a beginning and a set of guide posts. What is required is a general movement on the part of business firms to go to the financial aid of higher education. Such a movement would involve a myriad of individual company plans which, in the nature of the case, cannot be expected to bring great renown or publicity to their sponsors.

Rescue Operation Is Feasible

For the business community as a whole it is feasible to make a major and possibly a decisive contribution to putting our colleges and universities back on their feet financially. One percent of business profits before taxes would do it. In 1954 business profits before taxes were about $35 billion. If one percent of these profits, or $350 million, were contributed to our independent, privately endowed colleges and universities it would enable these institutions (1) to increase the salaries they pay by $200 million a year, and (2) to provide $150 million more for modernization and maintenance of their establishments. In the opinion of competent authorities, this would put these institutions in relatively good working order financially, a process to which a matching grant of $50 million by the Ford Foundation for the improvement of faculty salaries will make a large contribution. It would add about one-fourth to their present annual outlay of about $1.4 billion.

Such a contribution from business would not meet the needs of the independent institutions for new buildings and equipment required to accommodate the great increase in college enrollment anticipated in the years immediately ahead. Neither would it relieve the financial problems of our tax-supported colleges and universities. As a group these institutions have fared better financially in recent years than the

independent institutions. But they also face grave financial problems, particularly in the provision of adequate faculty salaries. It would be far simpler, however, to solve the financial problems of the tax-supported institutions if the independent colleges and universities were back on their feet financially.

One Dollar Does Work of Two

The federal government exempts 5 percent of business profits from the tax imposed upon them if the 5 percent is devoted to religious, charitable or educational purposes. (Most profits are taxed 52 percent.) A contribution of one percent of business profits to higher educational institutions would exhaust only one-fifth of this allowance. It would bring to about two percent the total share of business profits going to both educational and charitable purposes.

In 1953, business firms contributed about $400 million, or slightly more than one percent of profits before taxes to educational and charitable purposes of all kinds. Of this total about $75 million went to educational institutions, mostly colleges and universities.

For some companies it is feasible to contribute more than the average contributed by business generally. Indeed, some companies not only utilize their full 5 percent of tax-deductible funds for charitable and educational purposes but go beyond it. For other companies in financial difficulties no contribution at all is possible.

If, however, those business firms for which it is financially feasible contributed one percent of their profits before taxes to our colleges and universities, the problem of adequate support for the crucially important business of higher education would be far along the way to successful solution. **In 1954 a contribution of one percent of their profits before taxes, or about $350 million, would have reduced business profits after taxes by only about half that amount. This would have meant a reduction of about $175 million, out of a total of about $17.8 billion of profits after taxes.**

Attractive plans to channel financial aid from business to higher education have been abundantly demonstrated recently. These plans, for the most part the creation of large corporations, have included not only a broad array of scholarship grants, but such ingenious arrangements as that by which a company matches with its funds the gifts its employees make to the colleges of which they are alumni.

A full array of these plans, some of which were discussed in an earlier editorial in this series, has been prepared by The Council for Financial Aid to Education (6 East 45th Street, New York City 17) and is available for the asking. Also, colleges and universities have established in most states and regions cooperative associations to help business help them. The Commision on Colleges and Industry (912 Kahn Building, Indianapolis 4, Indiana) distributes a directory of these associations. And, of course, the colleges themselves are always eager to discuss their financial problems with business people and suggest constructive solutions.

Only Small Start Made

The plans for business aid to education which have recently attracted national attention constitute the conspicuous sort of leadership which it is the privilege and opportunity of our great corporations to provide. But the job is too large to be handled by a small number of business firms, no matter how bold or ingenious their programs.

To put our colleges and universities back on a firm footing financially the help of the great rank and file of business corporations is required. All of them, large and small, have a crucial stake in seeing that this job is done. The future of America will be decisively shaped by what happens in and to our college classrooms.

This message is one of a series prepared by the McGraw-Hill Department of Economics to help increase public knowledge and understanding of important nationwide developments that are of particular concern to the business and professional community served by our industrial and technical publications.

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Donald C. McGraw

PRESIDENT

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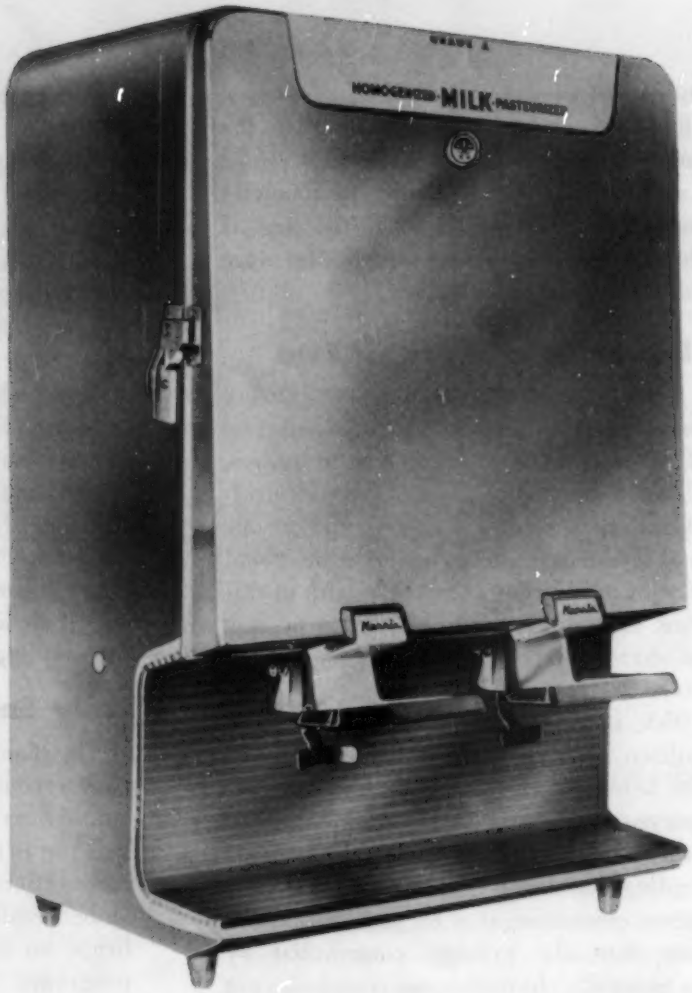

this attractive new dispenser of STAINLESS STEEL

meets every standard for cleanliness and top design

The Norristocrat is the newest addition to the line of milk dispensers manufactured by Norris Dispensers, Inc., of Minneapolis, Minnesota. It's designed by Raymond Loewy Associates and, like many Norris dispensers, it's Crucible stainless steel *inside and out.*

INSIDE, it's stainless to keep milk dairy-fresh, with flavor unchanged . . . to make cleaning easier . . . to meet all sanitary codes . . . and to satisfy the most exacting demands of schools and hospitals across the nation.

OUTSIDE, it's stainless to insure an attractive, lasting appearance that complements its clean, modern design . . . and adds to its promotional effectiveness for encouraging the consumption of milk.

Cleanability, product protection and bright good looks are the main reasons Norris insists on stainless steel. But stainless offers many other properties, too — among them corrosion and heat resistance, high tensile strength, excellent workability. And you'll find exactly the combination and degree of these properties you need in one of the thirty grades of Crucible stainless steel. To see what general and technical literature is available to help you make the most of Crucible stainless — or any other Crucible special purpose steel — write for your free copy of the Crucible Publication Catalog. *Crucible Steel Company of America, Henry W. Oliver Building, Pittsburgh 22, Pa.*

CRUCIBLE first name in special purpose steels

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Bearing Loads on Geared Shafts

Simple, fast and accurate graphical method of calculating both direction and magnitude of bearing loads

ZBIGNIEW JANIA
Project Engineer, Ford Motor Company

To calculate the bearing loads resulting from gear action, both the magnitude and direction of the tooth reaction must be known. This reaction is the force at the pitch circle exerted by the tooth in the direction perpendicular to, and away from the tooth surface. Thus, the tooth reaction of a gear is always in the same general direction as its motion.

Most techniques for evaluating bearing loads separate the total force acting on the gear into tangential and separating components. This tends to complicate the solution. The method described herein uses the total force directly.

If T is the torque transmitted by a gear, the tangential tooth force is

$$F_T = 2T/D,$$

Also, from Fig. 1,

$$F = F_T \sec \phi \quad \text{(spur gears)},$$
$$F = F_T \sec \phi_t \quad \text{(helical gears)}.$$

Since a force can be replaced by an equal force acting at a different point, plus a couple, the total gear force can be considered as acting at the intersection of the shaft centerline and a line passing through the mid-face of the gear, if the appropriate couple is included. For example, in Fig. 2 the total force on gear B is equivalent to a force F_B applied at point X plus the couple $b \times F_B$. In establishing the couples for the other gears, a sign convention must be adopted to distinguish between clockwise and counterclockwise moments.

If a vector diagram is now drawn for all couples acting on the shaft, the closing line will be equal (to scale) to the couple resulting from the reaction at bearing II. Knowing the distance between the two bearings, the load on bearing II can be found, the direction being the same as that of the couple caused by it.

The load on bearing I is found in the same manner by drawing a force vector diagram for all the forces acting at X including the load on bearing II found from the couple diagram.

(continued on page 211)

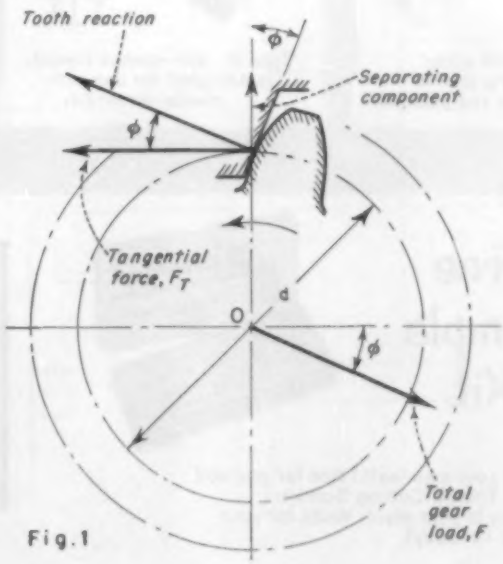
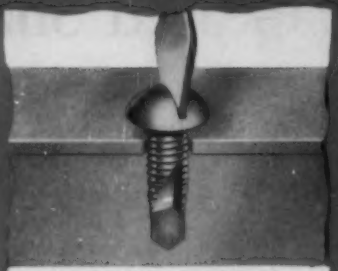


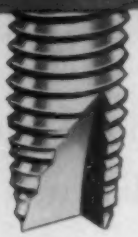
Fig. 1

Why SHAKEPROOF® THREAD-CUTTING SCREWS give a better fastening... faster!

Shakeproof Thread-Cutting Screws offer you immediate assembly savings.



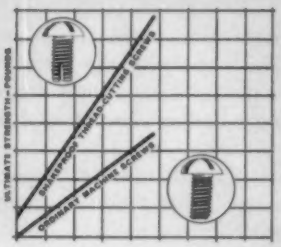
They cut their own threads, eliminate separate tapping operations completely.



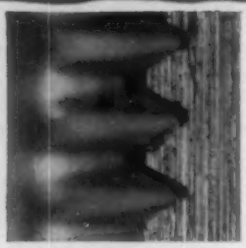
This thread-cutting slot exposes a sharp, serrated cutting edge.

Shakeproof Thread-Cutting Screws actually work with true tapping action.

You get big savings. Just drill or punch hole and drive—that's all! No tapping, no tapping tools!

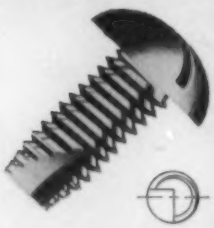


These hardened screws provide greater strength . . . often permit use of smaller sizes.



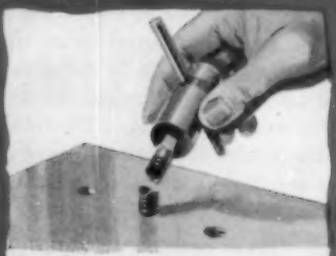
Self-cut mating threads assure a tight, vibration resistant fit.

Type 1 Thread-Cutting Screws are specially designed for use in hard metals.

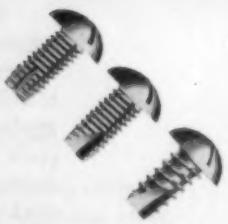


Type 23, with wider thread-cutting slot, is for use in metals and plastics.

Type 25, with spaced thread, is designed for use with plastic materials.



Eliminate costly taps and tapping . . . improve quality and cut costs at the same time.



Every screw is a cost saver when you specify Shakeproof Thread-Cutting Screws.

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WORLD'S BROADEST LINE OF MASS-ASSEMBLY FASTENINGS

Bearing Loads on Geared Shafts (continued from page 209)

The construction of both diagrams is illustrated on page 213. Referring to Fig. 2 the given data are

Pitch Dia. of Gears, in.		Moment Arm, in.	
A	2.00	a	1.50
B	1.50	b	3.50
C	4.00	c	5.00
Driver	1.75	d	7.00

Angle, deg		
α	55	Torque on driver ..... 100 lb-in.
β	48	Torque delivered by A ..... 40 per cent of torque on center shaft
γ	45	Torque delivered by B ..... 60 per cent of torque on center shaft
		Pressure angle of all gears, ϕ ..... 20 deg

Then,

Tangential force of driver = 200/1.75 = 114 lb
Torque on center shaft = 2 × 114 = 228 lb-in.

Gear loads are

$$F_A = \frac{0.4 \times 2 \times 228}{2.00} \sec 20 \text{ deg} = 97 \text{ lb}$$

$$F_B = \frac{0.6 \times 2 \times 228}{1.5} \sec 20 \text{ deg} = 195 \text{ lb}$$

$$F_C = 114 \sec 20 \text{ deg} = 121.5 \text{ lb}$$

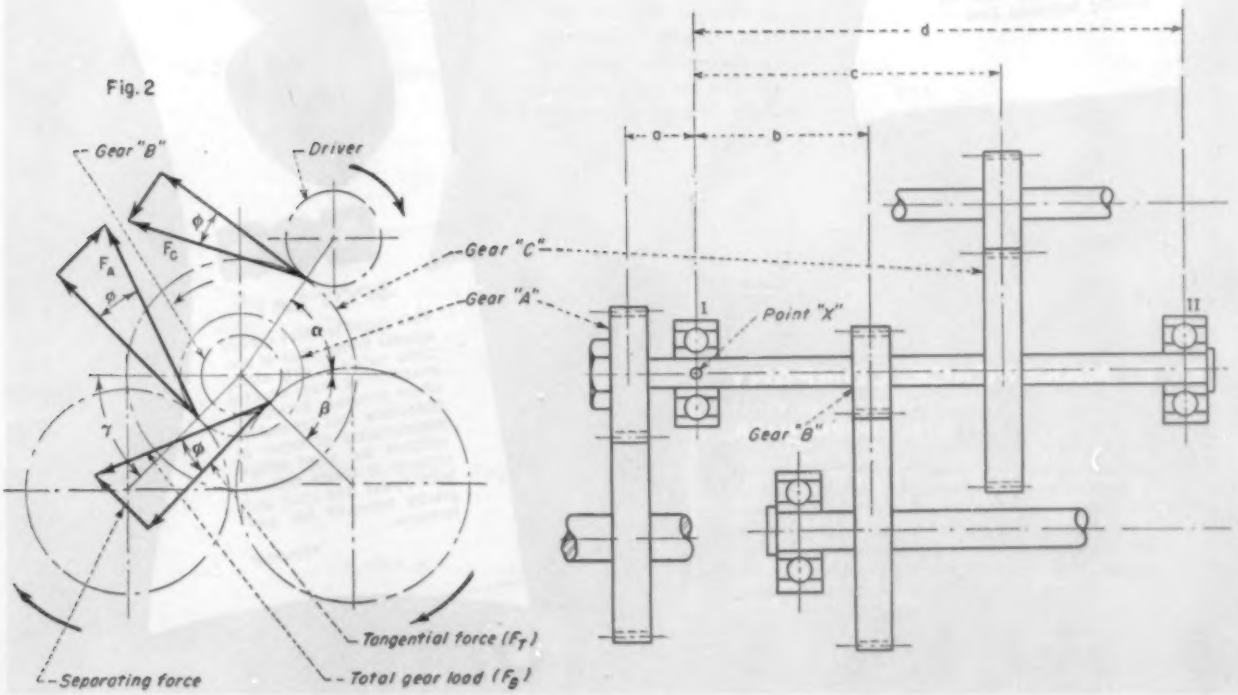
Before drawing the diagrams, it is convenient to collect all the data as in Table I. Then, the couple diagram, Fig. 3, is drawn. It is important to note that:

(a) Vectors representing negative couples are drawn in the same direction but in opposite sense to the forces causing them;

(b) The direction of the closing line of the diagram should be such as to make the sum of all couples equal to zero. Thus, the direction of 7 P_{II} is the direction of bearing reaction. The bearing load has the same direction but is of opposite sense.

(continued on page 213)

Fig. 2



PRECIOUS METAL LAMINATES BY

Makepeace

UNDERLINE DESIRABLE ELECTRICAL PROPERTIES

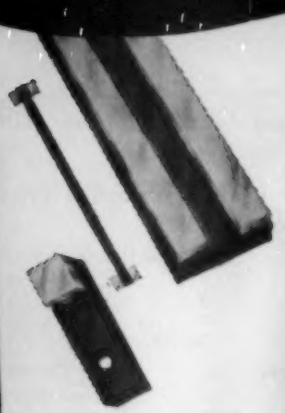
CORROSION RESISTANCE...ECONOMY

CROSSBAR CONTACTS

First used for miniature relays in telephone service, they now find widespread application in the current trend toward miniaturization. An important factor for easy, swift assembly is the fact that alignment of contacts is not critical.

Attachment by Makepeace machines effects major savings because they cut off and weld automatically. Further economies in precious metals result from the fact that laminated precious metal capped contacts are produced on tape in production runs and supplied on reels . . . eliminating need for handling individual tips.

For more than half-a-century, Makepeace has specialized in the production of finely finished laminated and solid precious metals. These are constantly held to the closest possible tolerances . . . have earned Makepeace the reputation of being the central source of supply for materials which meet the most exacting specifications. These Makepeace developments that fulfill rigid requirements for electrical qualities, corrosion resistance, economy and longer effective service life are here briefly described.



RAISED LAY

Here is a prime method for reducing costly assembly operations to blanking costs. Contacts made from Makepeace raised lay materials have greater hardness in both the bare metal and the contact tip in addition to longer life through being work-hardened. Any number of strips of silver may be bonded to base metal. Cold hard rolling produces dense contact surfaces for the most desirable electrical and mechanical qualities.

SPOT LAY*

This patented Makepeace process brazes slugs of precious metals in strip stock, positioning them exactly where required. Exclusively Makepeace, Spot Lay enables manufacturers of rotors in switches and small bridge contacts to secure material with lower end cost and greatly improved life performance.

*Patented

D. E. MAKEPEACE COMPANY
Division of Union Plate and Wire Co.
ATTLEBORO, MASS.

Sales Offices: New York • Chicago • Los Angeles • Columbus
Precision Rectangular Waveguide Tubing • Microwave Components • Microwave Transmission Assemblies • Electrical Contact Material • Formed Electrical Contacts • Crossbar Welded Contacts • Slip Ring and Slip Ring Assemblies • Brush Assemblies • Precious Metals Clad to Base Metals • Sheet Tubing Wire and Assemblies • Sendzmir Precision Rolling

Bearing Loads on Geared Shafts (continued from page 211)

The vector 7 P_{II} measures 1,148 lb-in. (to scale). Therefore, the reaction on bearing II is

$$P_{II} = \frac{1,148}{7} = 164 \text{ lb at } 11.5 \text{ deg}$$

This value of P_{II} is now used to construct the diagram of forces acting at point X, Fig. 4. The closing line of this diagram gives the value and direction of reaction on bearing I. The force vectors are drawn in the usual way in their respective directions and sense.

Thus, the load on bearing I is

$$P_I = 184 \text{ lb at } 27.5° \text{ deg}$$

The principle used in the above example to obtain loads on bearings supporting the center shaft shown in Fig. 2 can be applied to obtain loads on bearings carrying shafts with any number of gears. It is limited, however, to those cases which are statistically determinate.

Bending moment and shear diagrams for the shaft can now be determined since the magnitude as well as direction of all forces acting on the shaft are known.

Table I

Gear or Bearing	Dist. from Ref. Point X	Force, lb	Couple Lb-in. deg	Angular Position	
A	−1.50	97	−145.5	115	
I	0	P_I	0	0	unknown
B	3.50	195	621	202	
C	5.00	121.5	608	165	
II	7.00	P_{II}	7 P_{II}	δ	unknown

Fig. 3 - Couple vector diagram

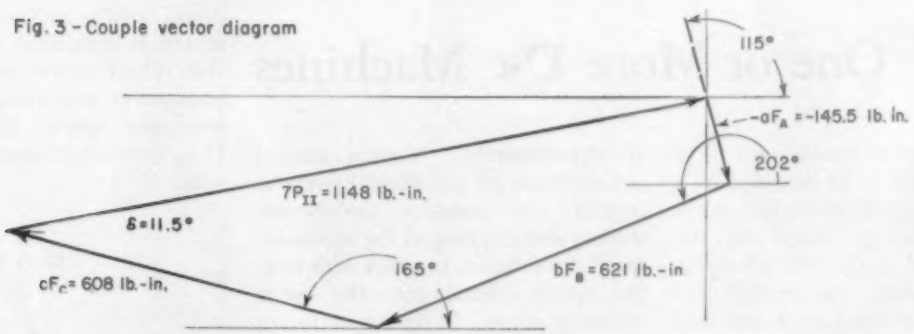
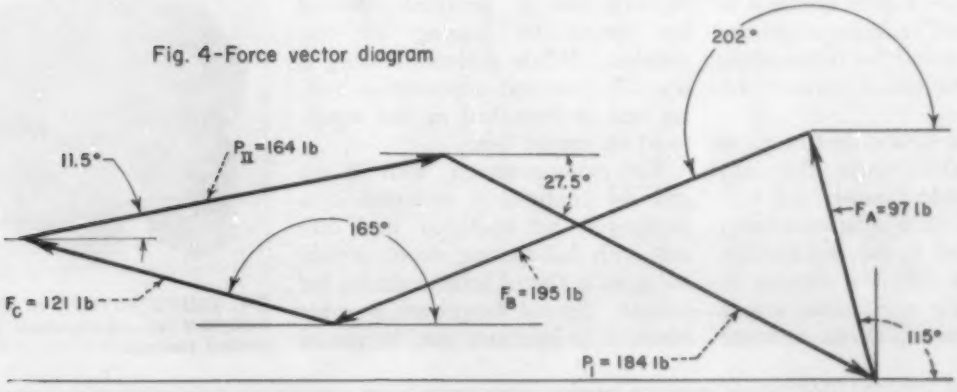
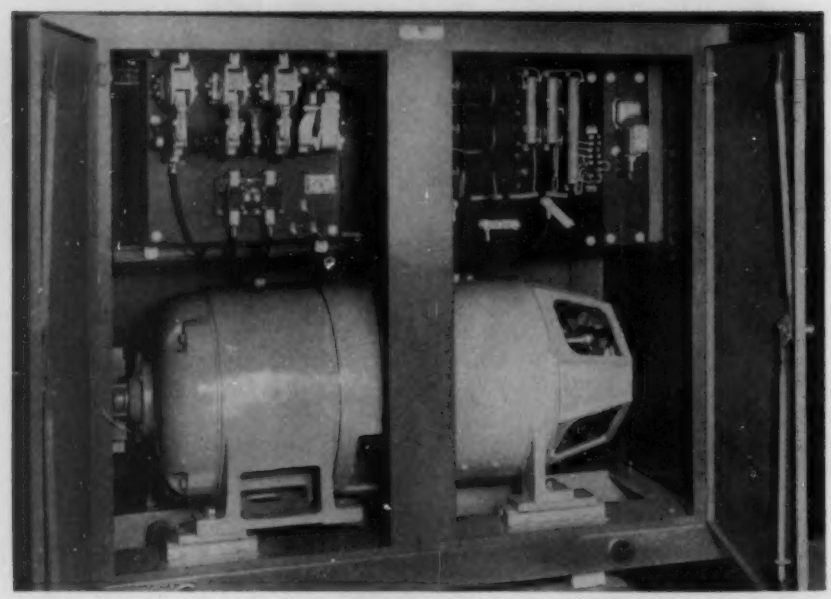


Fig. 4 - Force vector diagram



NEW COMPONENTS



MOTOR-GENERATOR SET, controls and rectifying unit for the new drive package are enclosed in a ventilated steel cabinet. D-c drive motors powered by this equipment are not shown here. Speed ranges up to 16:1 are standard; ratings are 10 to 125 hp.

Drives and Controls

One or More D-c Machines

A wide range of speeds with close regulation is said to be provided by a recently announced all-electric drive-and-control package based on the Ward Leonard system of adjustable voltage regulation. The package consists of a motor-generator set and rectifier unit for converting a-c power to d-c, a rheostat or other electrical or electronic control component and one or more d-c motors. No intermediate linkages or mechanical devices are used.

The new power-and-control package is applicable where the load requires: a) constant power and variable torque, as on a lathe or windup reel; b) constant torque and variable power, as on a conveyor, elevator or plastics extruder; c) variable torque and variable power, as on a mixer or dynamometer. Various control arrangements are possible The regular control unit provides push-button starting and stopping of the adjustable speed drive motor, together with stepless speed control over the entire operating range. Reversing by means of armature control and dynamic breaking can be provided. Pre-set low speeds for jogging are also possible. While dynamic braking is normally provided, regenerative braking can be furnished in this equipment on special order.

The motor-generator, with its a-c and d-c controls, is mounted in a pressurized, self-ventilated steel cabinet with full-opening doors. Ventilating air is filtered before entering the cabinet. Special flanges are available where it is necessary due to special operating conditions for intake air to be piped from outside.

Excitation for the fields of the motor-generator is supplied by a selenium rectifier. Electronic rectifiers are used when required by special control techniques.

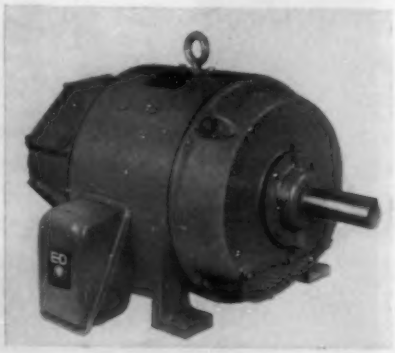
The full rated horsepower of the new drive is available at the drive-motor shaft. Overload protection of this motor is provided while the motor-generator is protected against both overload and undervoltage.

The speed range and torque of the new drive package can be changed by altering the size of the adjustable speed motor and making a minor change in control. By weakening the drive-motor field, the basic motor speed may be increased upward on a constant horsepower range.

Speed ranges up to 16:1 are part of the standard line, with ratings of 10 to 125 hp. A-c power requirements are two or three-phase, 60 cps, of 208, 220, 440 or 550 v.

The d-c drive motor supplied in this package are of the shunt-wound, ball-bearing, interpole type. Drip-proof, totally enclosed, fan-cooled or separately ventilated models are available. These motors provide a constant horsepower level from basic speed to maximum speed. Electro Dynamic Div., General Dynamics Corp., Bayonne, N. J.

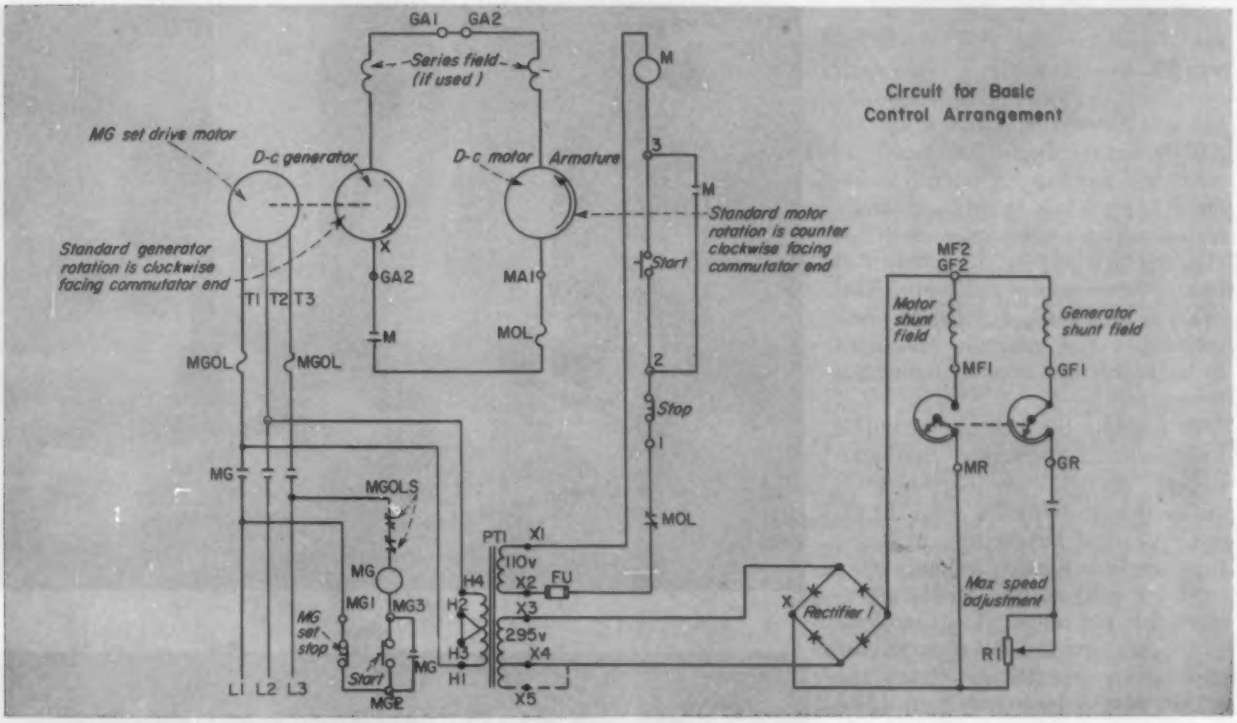
For more information—
Circle 1, inside back cover

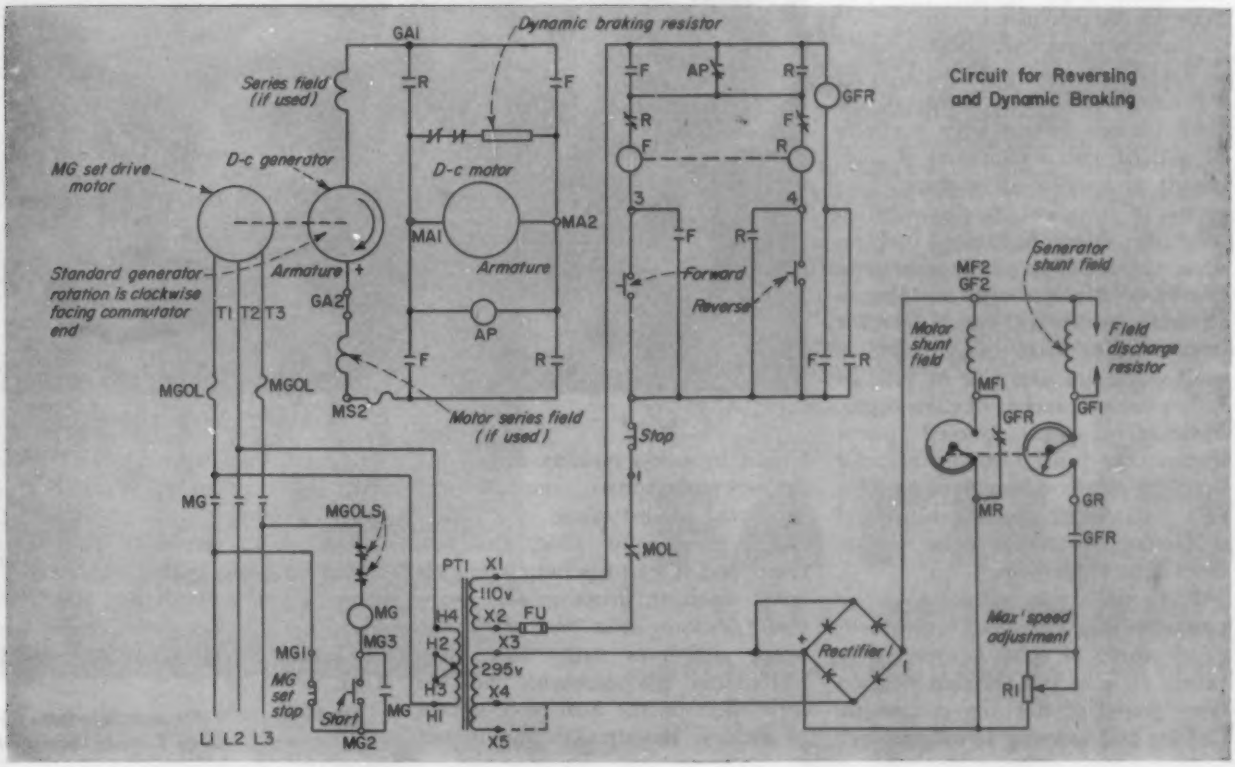


D-C DRIVE MOTOR of the type used with m-g set and regulator in drive-and-control package.

AND MATERIALS

SPECIFIED BY PRODUCT ENGINEERS





CONTINUED ON PAGE 216

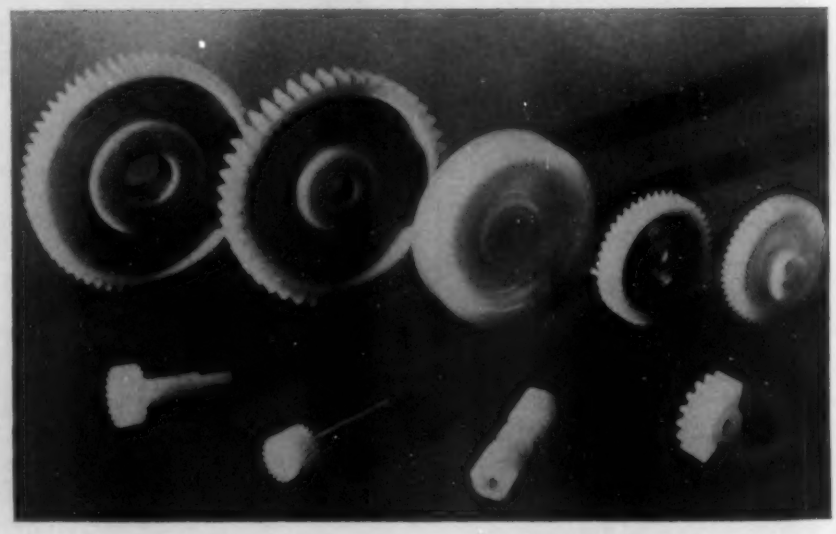
A Nylon That Extrudes and Molds Easily

Nylons as a class have always involved problems for molders. Below some temperatures they are too solid to extrude or injection mold. Above the lowest workable temperature they rapidly become fluid, so that containment is a problem. A recently introduced nylon is said to have a relatively high molten viscosity, which is expected to minimize the problem of leakage from nozzles and joints. This nylon is particularly adapted to blow-molding, a feat generally considered to be impractical from a commercial viewpoint.

In molding this new compound at low mold temperatures, maximum impact strength or toughness is obtained with minimum mold shrinkage. As mold temperature increases, the caprolactum nylon becomes more rigid, but even at 200 F mold temperature it is not brittle. This characteristic of controllable crystalline structure is expected to permit the molder or extruder to vary the finished product's final physical properties in thin sections, according to the producer of the new nylon.

The new nylon does not decompose or liberate gas during the molding or extrusion cycle. This permits very thick sections or very large pieces to be molded with a minimum of voids caused by trapped air or gases. As a matter of fact they are eliminated in most cases. Voids had been a problem up until now. This plastic compound can be cold-colored after molding, a technique which will appeal to those who want to make many colors in short runs, and who will be satisfied with a few millimeters of color depth. Molding of fully colored pieces requires the usual blending of color with the charge before molding. For very deep colors, a master batch and a blending operation can be used to obtain the shade desired.

Parts molded in natural color are opaque white. Easy recovery without development of color is expected to permit close to 100 per cent yield on every pound of this new compound. Cutting and redrying techniques well known by nylon molders permit full recovery of sprues, runners, and occasional spoiled pieces.



The grouping of which this new compound is a part is not completely water repellant, hence nylons absorb some moisture after molding in the nearly anhydrous state. This is an equilibrium phenomenon, and has little effect on the final piece—except to increase the strength and impact resistance at the expense of the tensile strength. There is no evidence that many cycles of saturation and drying will affect the product. The water absorption under normal conditions is about 1 per cent. Barrett Division, Allied Chemical & Die Corporation, 40 Rector Street, New York, New York.

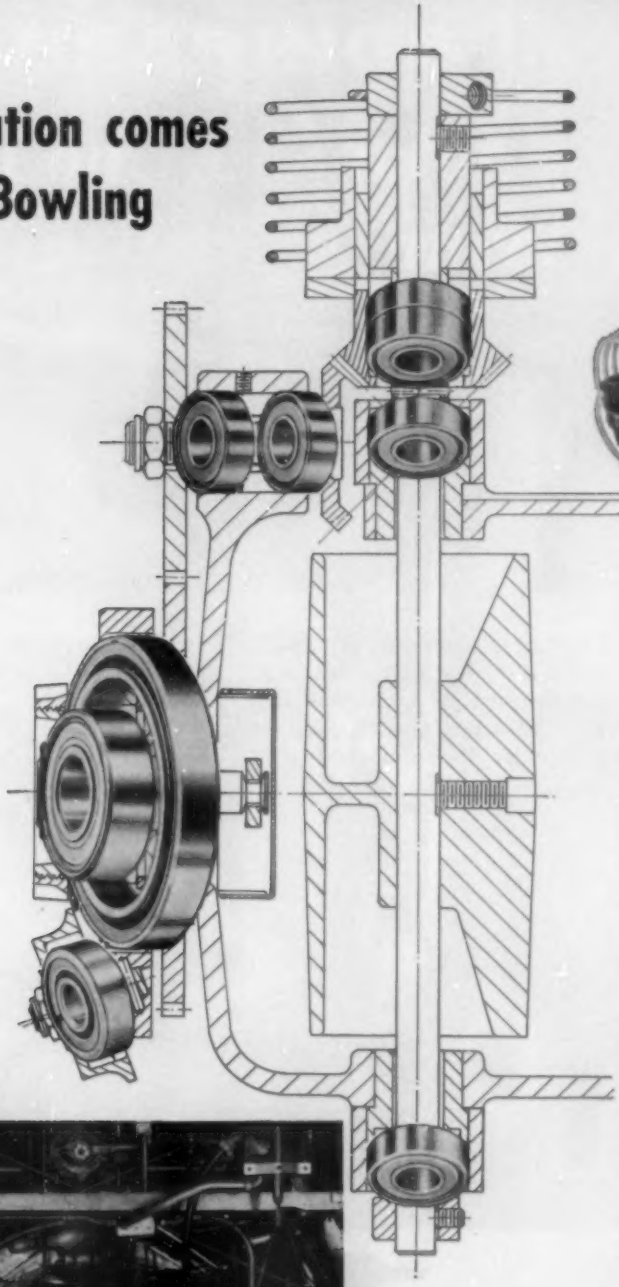
For more information—
Circle 2, inside back cover

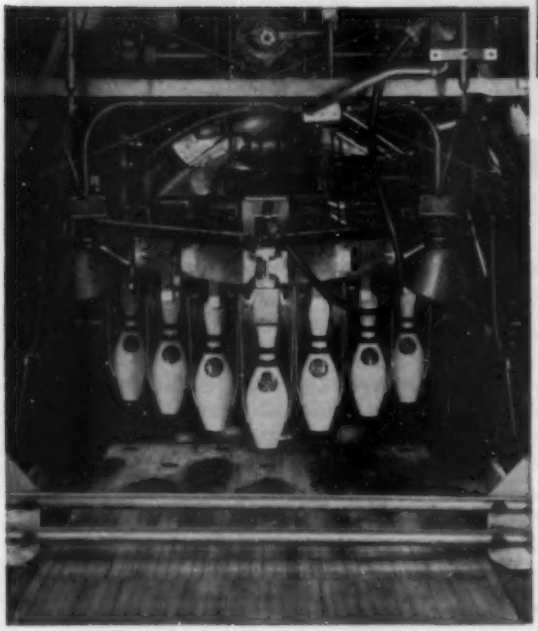
CONTINUED ON PAGE 218

Turning Points to more Efficient "Pin Boys"!

Automation comes to Bowling

Section of Pin Distributor Drive Head Assembly equipped with six Fafnir Extra Small Series Double-Shielded Ball Bearings including a duplex arrangement plus a 200 Series Plya-Seal Bearing located in housing within an Aircraft Type Bearing . . . also another 200 Series Bearing with Plya-Seals.





AMF Automatic Pinspotter is shown in process of lowering pins.

Watch an American Machine & Foundry Company Pinspotter in operation sometime, and you'll agree that it's an outstanding example of automation. This ingenious machine performs a multiplicity of complicated operations with amazing smoothness and dependability.

Incorporated in many of the turning points of the Automatic Pinspotter are Fafnir Ball Bearings . . . forty of them in all. They include several sizes of the 200 Series, Inch Type, and Extra Small Series, all with double grease shields . . . also three different Aircraft Type Ball Bearings with double Plya-Seals and a Flangette. Effectively placed, these ball bearings permit precise coordination of motion unhampered by friction.

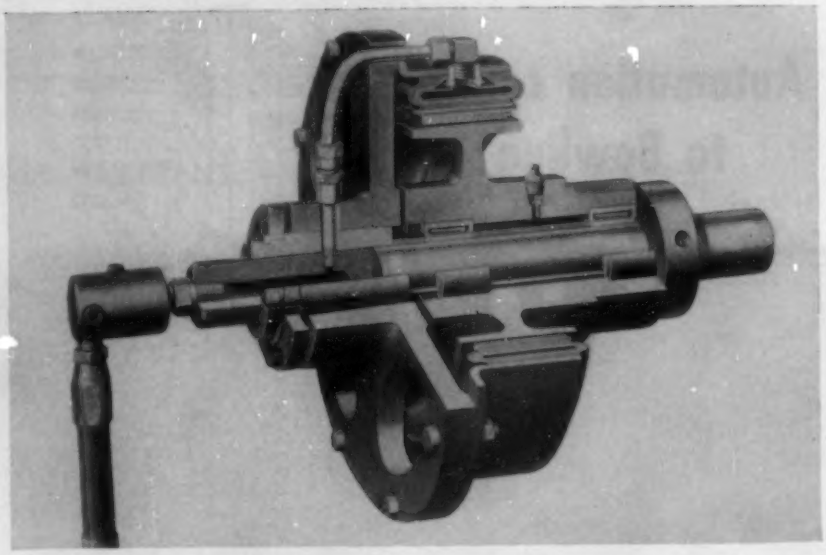
Here is another example of the Fafnir "attitude and aptitude" . . . a way of looking at bearing problems from the designer's viewpoint, plus coming up with the right bearing to fit the need. Automation problems and solutions are part of Fafnir's industry-wide experience. If you need the advantages of such experience, let Fafnir help you. The Fafnir Bearing Company, New Britain, Conn.

FAFNIR

BALL BEARINGS

MOST COMPLETE LINE IN AMERICA

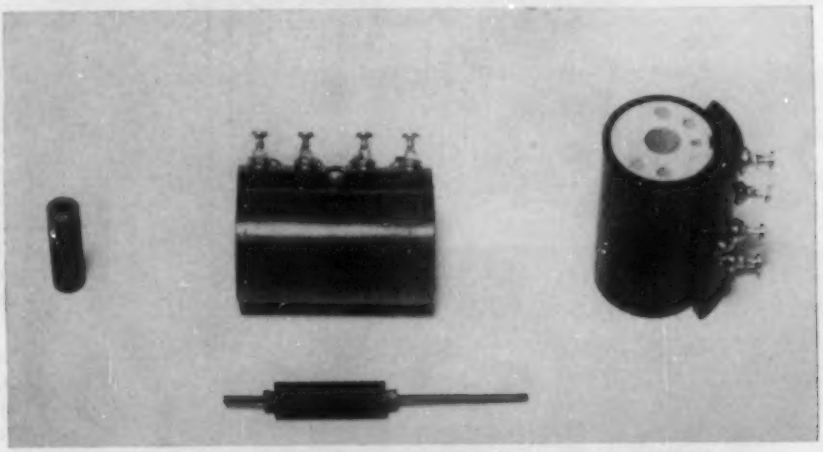
Pneumatic Clutches Of 1 to 31 Hp



Produced in a variety of sizes, these pneumatic clutches are said to provide 360 deg engagement, uniform friction pressure, instant response to electro-pneumatic controls, automatic compensation for wear of friction shoes and complete disengagement. In addition, these clutches are adaptable to cyclic or continuous operations and can be controlled either locally or remotely. Three types of units are included in the new series: (1) Spider bearing-mounted with tapered bushing (illustrated). This model has an extended drum hub mounted on anti-friction bearings. A mating sheave or sprocket can be readily adapted to the extended portion of the drum hub. (2) Spider gap-mounted with tapered bushing. This clutch-coupling makes possible simplified installation direct to a mating component. (3) Spider close-mounted with tapered bushings. This is designed for flexible coupling service. All types provide overload protection for the equipment with which they are used. Fawick Corporation, 9919 Clinton Road, Cleveland 11, Ohio.

For more information—
Circle 3, inside back cover

Position-Sensitive Transducers



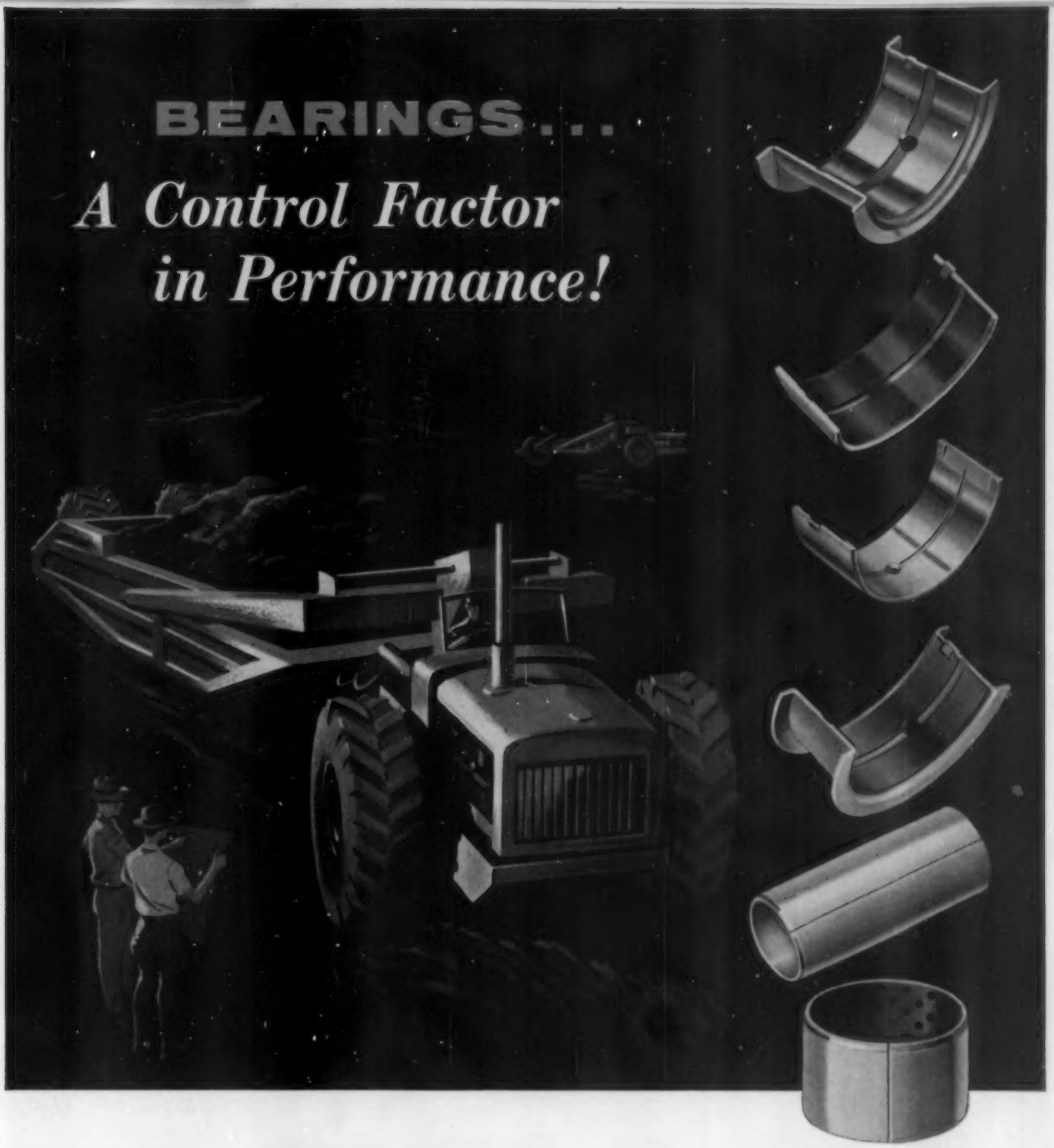
These miniature variable transformers, formerly produced only for use with this manufacturer's recorders and extensometers, have been designed for mounting by means of tapped holes, screw lugs or flat lugs. The standard size unit has a maximum core travel of 0.12 in. It is 1½ in long and ⅞ in. dia. A smaller size, 1 in. long and ⅝ in. dia, has a maximum core travel of 0.06 in. These are mounted by screw lugs or flat lugs only. These transformers may be used singly for direct measurement of the amplified output voltage or in pairs, as in stress-strain recording equipment. They consist of three coils of wire wound coaxially on a ceramic or plastic spool with an axial hole for a movable magnetic core. The central coil is the primary and the outer coils, connected in series to oppose each other, are the secondary. An outer iron cover provides magnetic shielding.

Displacement of the core either way from the neutral electrical center of the energized primary coil results in an output voltage that is a linear function of core displacement. Primary voltage is 10 v or less.

When used in pairs one unit is built into a strain follower so that its core is moved in proportion to the displacement to be measured. The other half of the pair is built into the self-balancing mechanism of a recorder. The voltage generated by the first unit is automatically balanced by corresponding movement of the recorder core, which is linked to a recording mechanism that magnifies core movement highly. Baldwin-Lima-Hamilton Corp., Philadelphia 42, Pa.

For more information—
Circle 4, inside back cover

CONTINUED ON PAGE 220



RESEARCH • DESIGN • METALLURGY • PRECISION MANUFACTURING

Earth-moving equipment demands rugged construction in every part—and sleeve bearings are no exception. They must carry tremendous thrust loads from pistons, protect costly crankshafts from excessive wear, endure extreme heat, maintain internal lubrication and on occasion withstand around-the-clock use and abuse. Quality at every step in their manufacture is essential to their vital role in performance. We are specialists in quality bearings and bushings for engine, transmission and chassis applications, and a major supplier to the earth-moving equipment building industry. Federal-Mogul Corporation, Detroit 13, Michigan.

SINCE 1899

FEDERAL-MOGUL

Dial Setting Automatic Reset Timer

This timer has a one-piece injection-molded acrylic front piece with vacuum metalized decorations and hot stamped graduations on inner surface. Outer surface has no fastener holes. An expansion nut assembly fastens cover securely from rear and simplifies removal of dial. Large knurled adjusting knob with integral time setting pointer are a part of the dial and cover assembly.

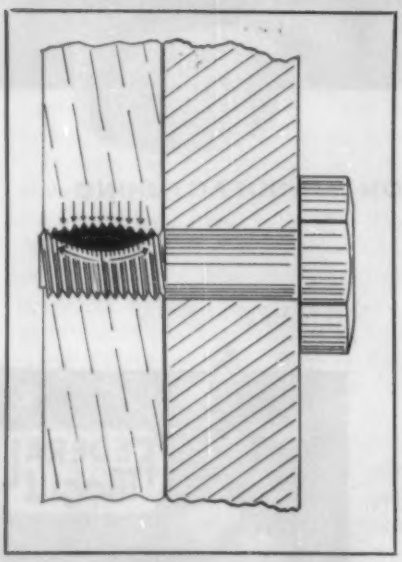
Timer mounts into a single round cut-out 3-3/16 in. dia and is secured in place by tension studs on a back-up ring held in position by an O-ring retainer. The unit can be installed in panels up to ½ in. in thickness, to suit varying design requirements.

The timer's design makes possible quick external inspection of motor operation, clutch engagement, elapsed time pointer operation, pointer reset and load switch actuation, without interrupting operation or process. Full internal inspection is said to be possible in 2 sec, while operating, by means of a pull tab on the O-ring retainer at the back of cylindrical cover. It can be completely serviced with ordinary screw driver and set screw wrench.

Self-cleaning contacts, easily interchangeable in the field, are rated at 10 amp at 115 v, ac, non-inductive. All timing ranges use the same internal operating mechanism, housed in basic chassis and cover, with interchangeable dials and motors making possible ten timing ranges: from 0 to 15 sec, with minimum setting of ¼ sec to 0 to 240 min with minimum setting of 240 sec. Automatic Temperature Control Company, 5200 Pulaski Avenue, Philadelphia 44, Pennsylvania.

For more information—
Circle 5, inside back cover

MECHANICAL COMPONENTS



Self-Locking Bolts Have Fibre Inserts

Self-locking male threads in the form of self-locking turnbuckles and special bolts and screws are said to eliminate the need for safety wiring, cotter pins, lockwashers, lock nuts, jam fits and staked bolts. A wide range of adjustment is possible with positive locking torque. The threads remain distortion-free and can be repeatedly removed and replaced without galling of threads.

The dimensions of the new thread fit standard nuts and the locking feature can be added to any type of standard screw form for custom threaded applications. Locking action is achieved by a convex fibre insert in the thread of the bolt. The locking action does not require high torque or special tools.

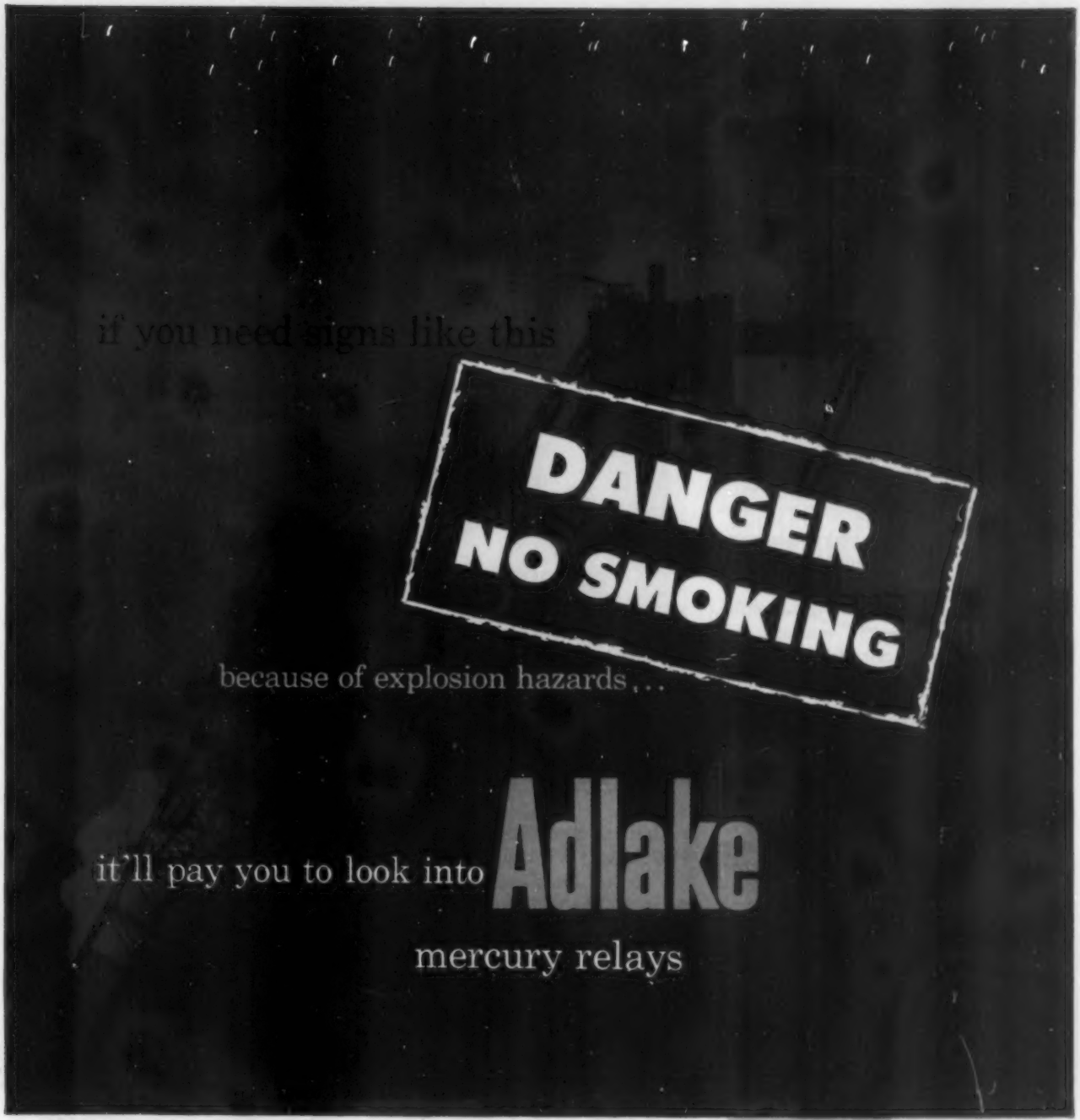
Turnbuckles employing this new locking method have been approved for use on military aircraft. Starloc, Inc., 235 Canal St., New York 13, N. Y.

For more information—
Circle 6, inside back cover

Bearing and Flange Unit

While designed primarily for shafts supported by sheet metal members, this assembly is a complete, single-package, pre-lubricated unit for use where the maximum capacity requirements do not exceed 1,000 rpm and loads of 200 lb. The flange of the unit, which actually is the bearing

CONTINUED ON PAGE 222



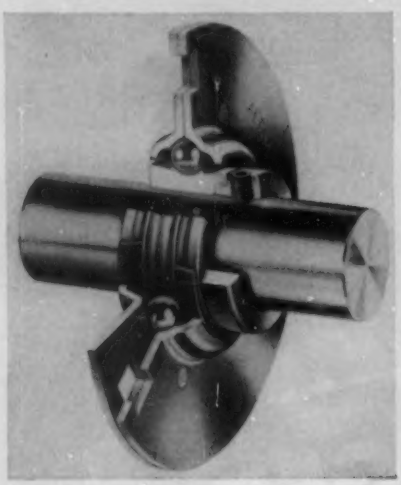
Adlake relays require no maintenance whatever ...are quiet and chatterless...free from explosion hazard. Dust, dirt, moisture and temperature changes can't affect their operation. Mercury-to-mercury contact gives ideal snap action, with no burning, pitting or sticking. Time delay characteristics are fixed and non-adjustable.

Adlake 98th year of serving the transportation and heating industries

The Adams & Westlake Company

Established 1857 • ELKHART, INDIANA • New York • Chicago

the *original* and largest manufacturers of mercury plunger-type relays



outer race, can be bolted in place and the shaft slipped through and secured by an eccentric locking collar.

The seal is said to be free-running, self-wiping, corrosion resistant and rust-free, locking out dirt and locking in the lubricant. The self-aligning bearing compensates for mounting inaccuracies, shaft or structural member deflections and misalignment up to ⅛ in. per ft. Aetna Ball & Roller Bearing Co., 4600 Schubert Ave., Chicago 39, Ill.

For more information—
Circle 7, inside back cover

Indexing Drives

Included in this line of drives are four, six and eight-stop units, with and without housings. They are high-speed, cam indexing mechanisms designed for inclusion in automatic production machinery employing dial feeds, roll feeds, carriers and chain or other types of intermittent feeding methods. It permits operating speeds up to 1,000 indexes per minute while maintaining extreme precision without auxiliary locating or locking devices. The drive is asserted not to require maintenance for at least 8,000 hr operation. Ferguson Machine & Tool Co., P. O. Box 191, St. Louis 21, Mo.

For more information—
Circle 8, inside back cover

Flange-Mounted Bearings

These self-aligning bearings are available in shaft sizes ranging from ½ to 1¼ in. They are recommended for medium loads and speeds ranging up to 5000 rpm. Nice Ball Bearing Co., 2925 Hunting Park Ave., Philadelphia 40, Pa.

For more information—
Circle 9, inside back cover

Worm Gear Reducer

For long, unsupported vertical output shaft extensions, this "steeple" type reducer has been used in a variety of applications. The wide bearing span insures rigidity for the extended shaft, while the "dry-well" construction eliminates the necessity of a stuffing box on the vertical shaft. To insure positive lubrication of the upper bearing on the vertical shaft, an automatic reversing oil pump, together with a filter, is contained within the unit housing. Philadelphia Gear Works, Erie Ave., and G St., Philadelphia 34, Pa.

For more information—
Circle 10, inside back cover

Variable Speed Pulley

A pulley that provides ratios up to 3 to 1 at 7½ to 15 hp is said to require only finger-tip pressure to change speed while machinery is in motion.

Used in conjunction with a 1750 rpm motor, maximum rating is 10 or 15 hp, depending on base used. Belt accommodated has a 2¾ in. top width. Standard bores are 1¼, 1⅜, 1⅝ in. Lovejoy Flexible Coupling Co., 4873 W. Lake St., Chicago 44, Ill.

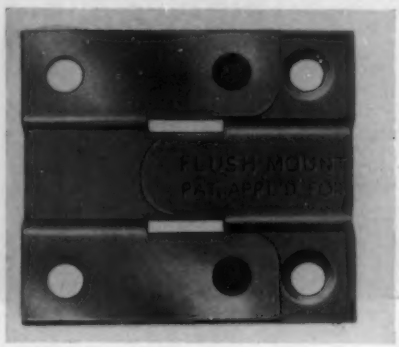
For more information—
Circle 11, inside back cover

Double Reduction Speed Reducer

This speed reducer has a zinc alloy housing and is available in ratios of 4:1 to 1600:1. Torque capacities are 25 to 150 lb-in., ⅛ hp.

These reducers are furnished with roller bearings. Bronze sleeve bearings are also available, where applications permit. Ohio Gear Co., 1333 E. 179 St., Cleveland 10, Ohio.

For more information—
Circle 12, inside back cover

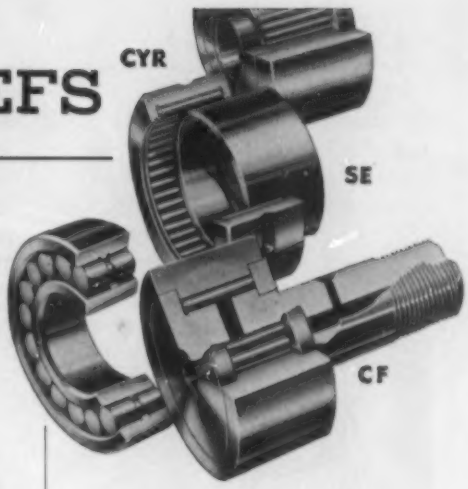


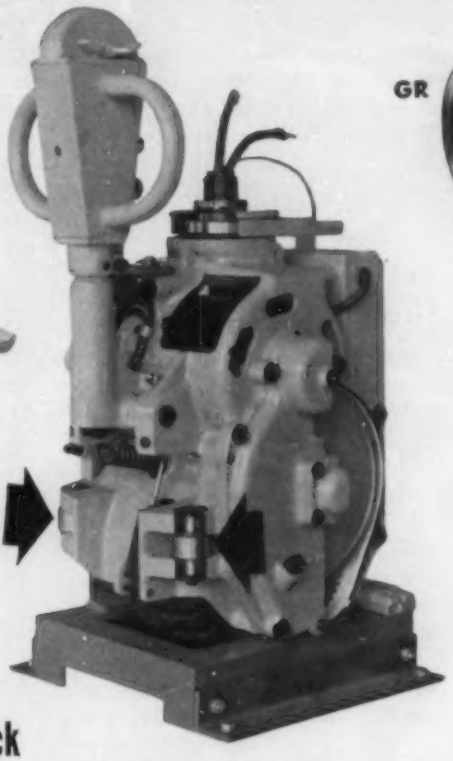
Fastener for Flush Mounting

Secure hanging ⅛ in. from surfaces is said to be possible with this fastening device. One section is attached to the surface and one to the supported object. Both are stamped out of No. 14 gage sheet steel and are cadmium plated. The new mounts are produced in two dimensions, 1 x 1 in. and 1¼ x 1¾ in. Two countersunk holes for mounting are punched in the smaller unit, and four in the larger. Normally,

CONTINUED ON PAGE 224

McGILL BEARING BRIEFS





Sealed GUIDEROL® bearings meet design demands of Clark *POWRWORKER* hand truck

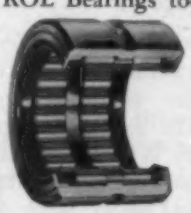
The power head in Clark Equipment Company's Powrworker trucks required a bearing to provide radial support to the wheel-mounted pivoting drive unit. In addition it had to seal out dirt, carry a sizeable load in limited space and adapt to vertical mounting. Sealed GUIDEROL bearings meet each of these requirements.

For instance, the bearings are only 4½ inches above the floor and in contact with contaminating materials such as dirt, chemicals and brine that would freeze up ordinary unsealed bearings. Use of the Sealed GUIDEROL bearings eliminates the need for multiple parts and extra machining of the housing that would be required with auxiliary sealing of an ordinary bearing.

Although limited in size by the fit of the unit into the truck, the GUIDEROL SG Bearings take loads up to 1,500 pounds in absorbing starting and stopping inertias of the truck and the unit.

The SG Series bearings operate perfectly and last longer in vertical mounting because the center guided construction provides a guide rail that keeps the grooved rollers in alignment under any load from vertical to horizontal. They are available with built-in single and double seals with no increase in standard Guiderol bearing width.

To help insure product performance and to simplify production and assembly, investigate Sealed GUIDEROL Bearings today.



FOR YOU

Complete details on the Sealed GUIDEROL Bearing are contained in McGill Catalog No. 52. Send for a copy today.

SIKORSKY USES SEALED GUIDEROL® BEARINGS in HELICOPTER ROTORS

An obvious "must" for helicopter rotors is dependability. McGill Sealed GUIDEROL Bearings help to provide that dependability as drag hinge and flapping hinge bearings in the main and tail rotors of the Sikorsky S-55, helicopter series.

SEALED GUIDEROL® BEARINGS BRING NEW LATITUDE in DESIGN to SCOTT-ATWATER MOTORS

Used as crankshaft support in the new Scott-Atwater Bail-a-matic outboard motor line, Sealed GUIDEROL bearings give more positive seal retainment, make higher operating speeds possible, give greater capacity for future horsepower increases, and simplify assembly.

Insure performance with McGILL® . . .

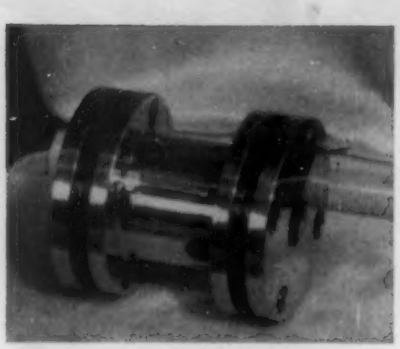
50th McGILL Anniversary

MULTIROL®—GUIDEROL®—CAMROL full type roller bearings

McGILL MANUFACTURING COMPANY, INC., 201 N. LAFAYETTE ST., VALPARAISO, INDIANA

the male unit is attached to the object and the female part to the surface. Harvest House Mfg. Co., 453 S. Robertson Blvd., Beverly Hills, Calif.

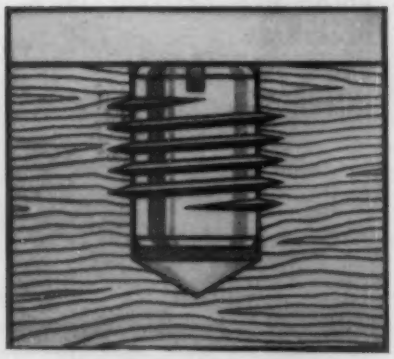
For more information—
Circle 13, inside back cover



Flexible Coupling

This coupling weighs ½ oz, is non-magnetic (aluminum-beryllium copper construction) and has minimum backlash (no sliding parts). Crosspull and end thrust on connected shafts is minimized by the extreme flexibility of the coupling. This product is particularly well adapted for selsyn or other drives where backlash cannot be tolerated. Furnished in all bore sizes up to ¼ in. Thomas Flexible Coupling Co., Warren, Pa.

For more information—
Circle 14, inside back cover



Insert Puts Steel Threads in Wood

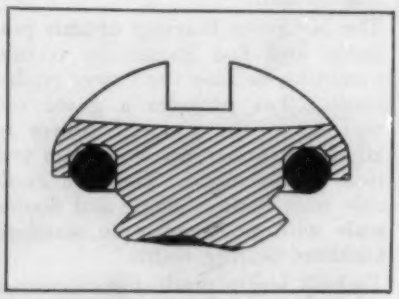
This insert has an external thread which is said to cut its way into wood without crushing the fibers. The insert's tapped thread on the ID permits bolts or screws to be assembled or disassembled many times without damage to threads or loss of holding power in the parent material. Made of high-quality steel and cadmium-plated, these inserts are available in various sizes with either fine or coarse internal threads. Rosan, Inc., 2901 W. Coast Highway, Newport Beach, Calif.

For more information—
Circle 15, inside back cover

Aircraft Panel Fastener

According to the manufacturer, this aircraft panel fastener has been modified by developing an all-steel receptacle which conforms to MIL-F 5591A specification for Style 3 applications and can also be used in Style 1 and 2 applications. A permanently assembled stud and grommet have been developed for use with this all-steel receptacle in Style 3 applications, and the studs presently used in Style 1 and 2 applications can also be employed with this new receptacle. Scovill Mfg. Co., Waterbury, Conn.

For more information—
Circle 16, inside back cover

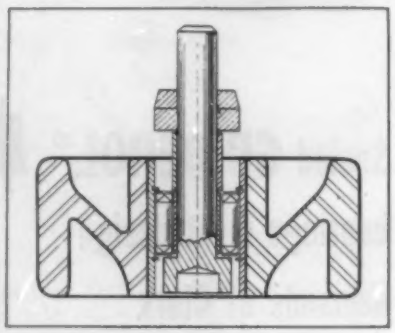


Self-Sealing, Shake-Proof Screws

A line of machine screws has been designed for use on hermetically sealed cabinetry or under conditions of severe vibration. The screws are supplied by the factory as integral units and they require no assembly on the part of the user. An "O-rib" made of silicone rubber, neoprene or plastic, depending on the end use of the screw, is held in a circular groove under the screw head. When the screw is tightened, the material is compressed under the head to form a positive hermetic seal. Wherever a "locking" or "shake-proof" screw is required, a plastic is used in place of the rubber.

To all outward appearances these screw heads are identical with all standard screws. These screws are made of brass or steel, plain or nickel-plated, in sizes 6-32, 8-32, and 10-32. Automatic & Precision Mfg. Co., 252 Hawthorne Ave., Yonkers 5, N. Y.

For more information—
Cicle 17, inside back cover



Flexible Conveyor Roll

A series of flexible conveyor rolls, designed to handle formed, painted, embossed or enameled parts without damage or distortion, are made of specially-compounded synthetic rubber. The rolls are oil-resistant, and feature a "Z"-type cross-section which is said to instantly and continuously conform to the varying contours of moving loads. Design of the rolls incorporates pre-lubricated roller bearings engineered to absorb high shock loads. Bearings are centered in dust-proof, lint-proof retainers, and operate on a centerless-ground inner race for maximum durability.

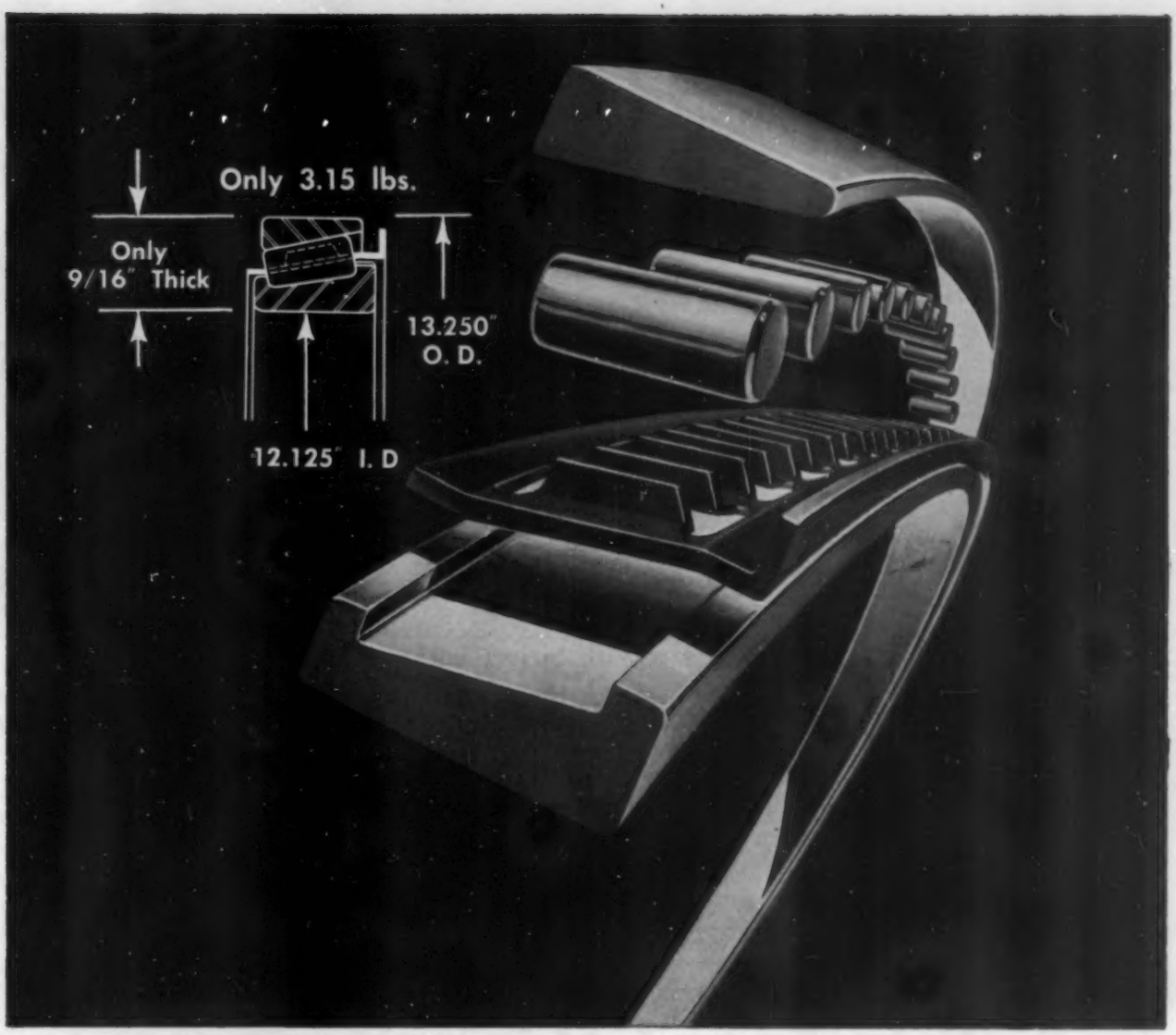
The conveyor rolls are supplied completely assembled, with ½ in socket head cap screws, tube-type spacers and self-locking jam nuts. Boxley Co., 7410 Woodward, Detroit 2, Mich.

For more information—
Circle 18, inside back cover

Hydraulic Cushioning Spring

A hydraulic spring with built-in valve for dampened return to cushion impact is said to produce up to 3,600

CONTINUED ON PAGE 226



Kaydon...

world's thinnest tapered roller bearings

Reali-Slim — that's the name we've given our line of extremely thin-section, lightweight bearings. The bearing shown above is a *Reali-Slim*. *Reali-Slim* bearings are really strong, too! The single row, tapered roller bearing we're talking about, here, has a 33,000-lb. radial capacity—with 38,200-lb. thrust capacity. Over 1-ft. in diameter, yet it weighs only 3.15 lbs! These figures tell how *Reali-Slim* bearings combine minimum section with high strength and long life.

If you're looking for a whole new concept in thin-section, lightweight bearing design — look at Kaydon's *Reali-Slim* line. In addition to hundreds of *Reali-Slim* standard sizes, there's a big variety of special races and separators to meet special applications. Kaydon engineers are prepared to give you valuable help with your application problems.

For more information write Kaydon of Muskegon. Ask for engineering Catalog No. 54-RS detailing:

★ ***Reali-Slim Ball Bearings*** — in Conrad, angular contact and 4-point contact types are available in seven standard cross sections from ¼" to 1.000" and in bore diameters from 4" to 40.000".

★ ***Reali-Slim Roller Bearings*** — in radial and taper roller types are available in cross sections from 9/16" and in bore diameters from 5" to 40.000".

THE KAYDON ENGINEERING CORP.

MUSKEGON • MICHIGAN

All types of ball and roller bearings — 4" to 120" outside diameter . . .

Taper Roller • Roller Thrust • Roller Radial • Bi-Angular Roller • Spherical Roller • Ball Radial • Ball Thrust Bearings.

lb force at 1 in. stroke. It is also available with any spring and dampened return force combination.

This new spring is 4¾ in long, including 1 in. stroke, and 2¾ in. dia. Wales Strippit Corp., 345 Payne Ave., North Tonawanda, N. Y.

For more information—
Circle 19, inside back cover

Grease Fitting Has Ball Check In Top

These grease fittings incorporate the ball check in the head instead of in the throat, as is the case with all conventional fittings. This is said to permit wiping head of fitting clean before contacting with grease gun, without danger of pushing accumulated dirt into throat of fitting. In turn, this eliminates the hazard of forcing grit, collected in an open throat, into bearings.

A larger internal diameter of lubricant passage is reported to admit a greater flow of grease. Tempered music wire spring is coiled so that it will not restrict flow of lubricants, or be forced out of body by pressure. Commonly used fitting styles and thread sizes are available. Lincoln Engineering Co., 5701 Natural Bridge Ave., St. Louis 20, Mo.

For more information—
Circle 20, inside back cover

Casters With Swivel Locks

A four-position, plunger-type swivel lock which prevents accidental swivelling or rolling of casters is available on this manufacturer's 6, 8 and 10 in. heavy duty casters. The new device permits locking the caster swivel at 90 deg increment. When unlocked, full 360 deg normal swivelling can take place. Bassick Co., Bridgeport 2, Conn.

For more information—
Circle 21, inside back cover

brake pressure is controlled by hand; the pressure is instantly released by the foot throttle. Power Brake Equipment Co., 1632 S.E. 11 Ave., Portland, Ore.

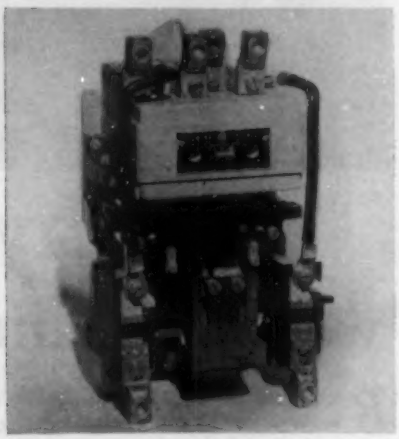
For more information—
Circle 22, inside back cover

D-c Torque Motors for Both Dc and Ac

A line of precision motors which were originally developed for missile applications includes one model with a torque of 66.7 oz-in (± 5 per cent) at 25 v on continuous duty. The torque is linear with respect to voltage within ± 5 per cent from 0 to 50 v. For intermittent use, on a 10 per cent duty cycle, 200 oz-in (± 5 per cent) torque is obtained at 75 v.

The weight of this model is 4½ lb. The outside diameter is 2⅞ in., with overall length 2⅛. Gray & Huleguard, Inc., 930 N. Hancock Ave., Los Angeles 46, Calif.

For more information—
Circle 23, inside back cover



Vertical Lift Magnetic Starter

A NEMA size 4 magnetic starter has been designed for motors of up to 100 hp. The starter is the same size and has the same mounting dimensions as the size 3 model, according to the maker. Strongbox coil design includes a cast-on plastic case for maximum protection of coil windings. A permanent air gap causes the starter to drop out when de-energized

ELECTRIC POWER, CONTROL

Compression Brake System

This device converts a truck engine into a low pressure air compressor which slows down and holds back the vehicle. It can be installed in both gasoline and diesel-powered trucks. Installation of a special port between the carburetor and the intake manifold (in gasoline engines), and the placement of a butterfly valve between the manifold and the muffler, which restricts the escape of the exhaust from the manifold, achieves the compression. On the first downward stroke of the piston (the inlet valve being open and the exhaust valve closed), pure air is drawn in through the port. On the return stroke, (both valves closed) the air is compressed. On the next downward stroke, the air is decompressed (throttle at idle.) On the next return stroke the exhaust valve is open, but the butterfly valve restricts the exhaust's escape. Each succeeding exhaust stroke builds up pressure, and a braking influence is achieved almost equal to the horsepower output of the engine.

The operation of the new brake system is controlled by the driver with a hand valve on the steering post, together with a gage showing manifold pressure. The amount of

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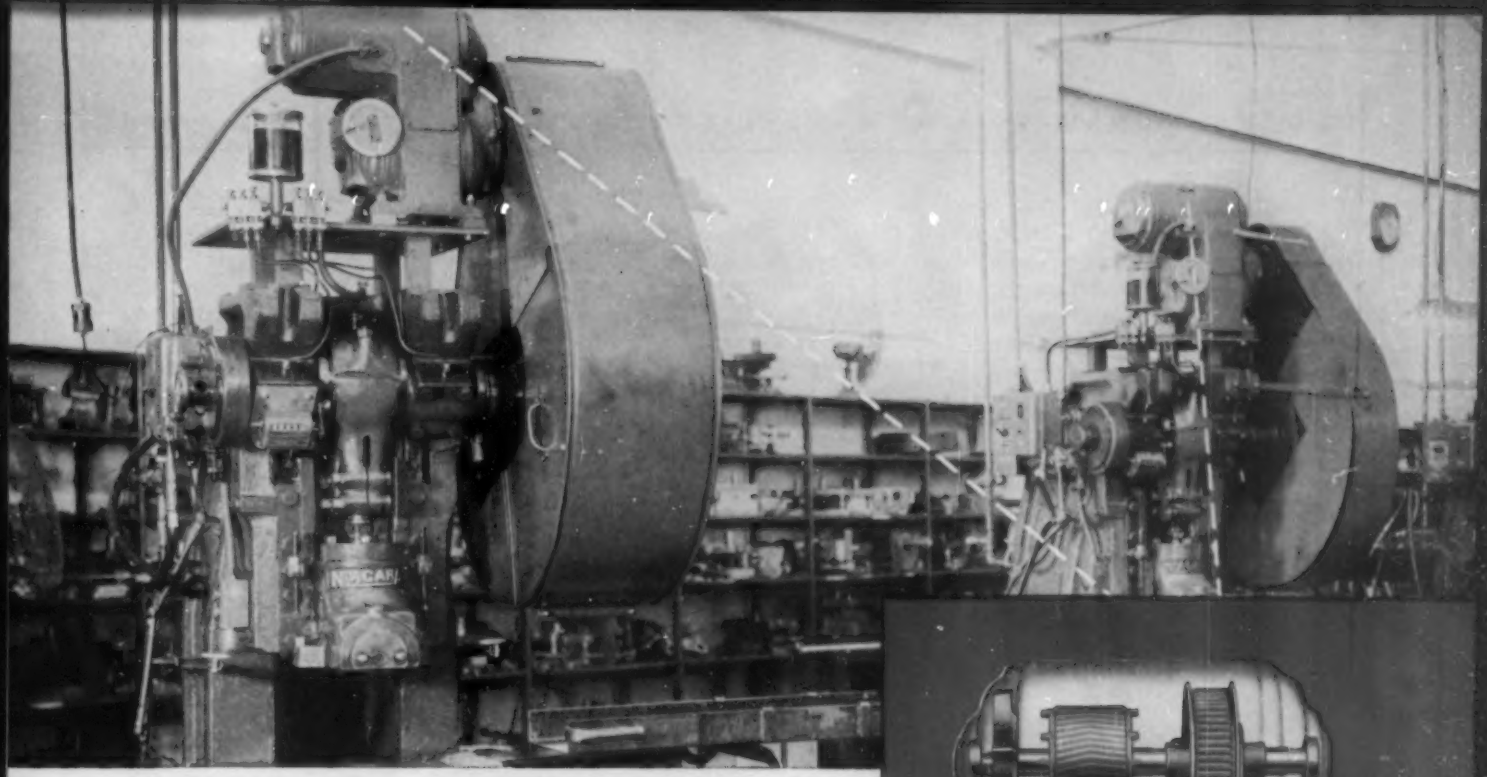
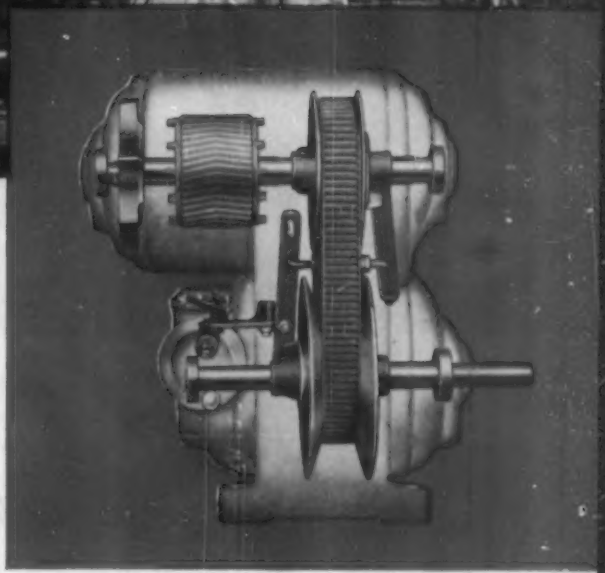




PUNCH PRESS OUTPUT UP 30% WITH SPEED-TROLS AT SQUARE D CO.

Replacement of single speed motors with Speed-Trol variable speed drives on punch presses at the Los Angeles factory of Square D Company resulted in the following advantages, reports L. G. Maechtlen, Vice President: Production increased 30%... spoilage or rejects reduced 10%... presses adapted to 40% more jobs... 100% synchronization of punch press speed and operator's ability... employee morale greatly improved.

Speed-Trol...Variable Speed at its Best

OUTSTANDING FEATURES:

A Single, Compact Power Unit containing motor, variable speed transmission, with or without integral speed reducer—**Effective Cooling Systems** with direct-through ventilation, dual or internal cooling—**Positive Pulley Adjustment** for infinite speed variation, accurate speed selection and regulation—**Fingertip Control of Speed** with standard or remote controls—**Specially Designed V-Belt** for heavy duty, long life—**Protected Designs,** drip-proof, splash-proof, totally enclosed—**Rugged Construction** for continuous duty, permanent bearing alignment—**Streamlined** for easy cleaning, better appearance—**Interchangeable Mounting Dimensions** between constant and variable speed drives—**Versatile Mounting** for any position—**Smooth, Quiet Operation** through dynamic balancing; Herringbone Rotor; pre-lubricated, double shielded ball bearings—**Low Installation Cost** due to compact design, versatile mounting, interchangeable mounting dimensions.

20-PAGE ILLUSTRATED CATALOG ... Sterling Speed-Trol, Slo-Speed, Klosd and Klosd-Tite Electric Power Drives. Write for catalog No. 203.

There is a Sterling Electric Power Drive to Meet Virtually Every Requirement

Sterling Slo-Speed Electric Power Drives—for geared low speed at its best
Sterling Klosd and Klosd-Tite Motors—for constant normal speed at its best

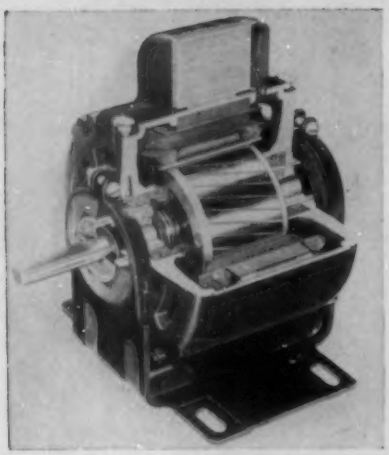
STERLING ELECTRIC MOTORS

Plants: New York City 51 • Chicago 35 • Los Angeles 22 • Hamilton, Canada • Santiago, Chile
Offices and distributors in all principal cities

regardless of age and usage, and a new type of bi-metallic overload relay provides overload protection comparable to that available in smaller sizes.

Suitable for operation of polyphase motors in ratings of 220 v, 50 hp and 440/550 v, 100 hp, the new starter is available in reversing, multi-speed, and combination forms, and can be obtained with either vertical and horizontal mechanical interlocks. General Electric Co., Schenectady 5, N. Y.

For more information—
Circle 24, inside back cover



Motor For Direct Drives

This motor's stator is die cast under high pressure to prevent shifting and vibration of laminations during manufacturing, handling and motor use. Completed core, end bells, bearings and shafting are machined. Use for direct drive blower applications in larger sizes eliminates the belts, blocks, pulleys, shafting and motor mount in conventional blower installations. This new permanent split capacitor motor is available in ratings from 1/10 to 1/3 hp. Redmond Co., Inc., Owosso, Mich.

For more information—
Circle 25, inside back cover

Gear Motor With Parallel Shaft

This universal gear motor is available in any voltage up to 250, and in speeds as low as 1 rpm. The unit is designed to meet loads to 15 lb-in.

The motor can also be built with an electric governor speed control. The motor can be rheostat controlled, dynamically or mechanically braked. Rae Motor Corp., P. O. Box 291, Racine, Wis.

For more information—
Circle 26, inside back cover

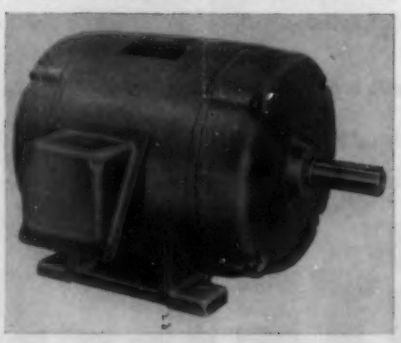
Miniature Permanent Magnet Motor

This motor weighs 5 oz and measures 1.25 in. OD x 2.14 in. long. Temperature range is from — 55 C to 71 C. Motor speeds range from 6000 to 20,000 rpm. Speeds are controllable to ± 1 per cent over a voltage range from 24 to 29 v by using a governor. The motor is available with gear train, governor, brake or any combination thereof. John Oster Mfg. Co., 1 Main St., Racine, Wis.

For more information—
Circle 27, inside back cover

General Purpose Polyphase Motors

A line of ball bearing motors in rerated NEMA frame sizes 182 through 326 have their ventilating air intakes located at the bottom of the endplates. Air outlets are positioned at the base of the frames on each side. Specially formed baffle plates direct air into the blowers and through the motor and also provide extra protection for the stator windings.



These new motors are provided with means for relubricating the bearings when necessary. They will be available in 1 to 30 hp ratings, three-phase, 60 cps, 1750 rpm. Wagner Electric Corp., 6400 Plymouth Ave., St. Louis 14, Mo.

For more information—
Circle 28, inside back cover

Explosion-proof 1 to 25 hp Motors

UL-approval has been received for these units for use in all Class I, Group D, and Class II, Groups E, F, and G hazardous locations. They are available in ratings of 1 to 25 hp., three-phase, and 1 to 3 hp, single-phase. Louis Allis Co., Milwaukee 7, Wis.

For more information—
Circle 29, inside back cover

Four-Pole Shaded Pole Motor

This motor is rated at 1/60 to 1/30 hp. It can be supplied to operate at speeds between 900 and 1550 rpm, at rated input of 115 v, ac. At reduced voltages, very stable speeds as low as 400 rpm can be attained. The SP-25 can be operated in vertical or horizontal positions. Three standard frames with double or single shaft extensions are available. Electric Motors and Specialties, Inc., King and Hamsher St., Garrett, Ind.

For more information—
Circle 30, inside back cover

Nuclear Electrical Battery

A nuclear battery that converts nuclear energy into elecrical energy has been developed that is reported to perform reliably under temperature conditions ranging from — 60 F to 160 F. The battery has an operating life in excess of 25 yr. Three models are available with voltage and current ratings ranging from 1 to 10,000 v and 5 to 2,000 micromicroamperes.

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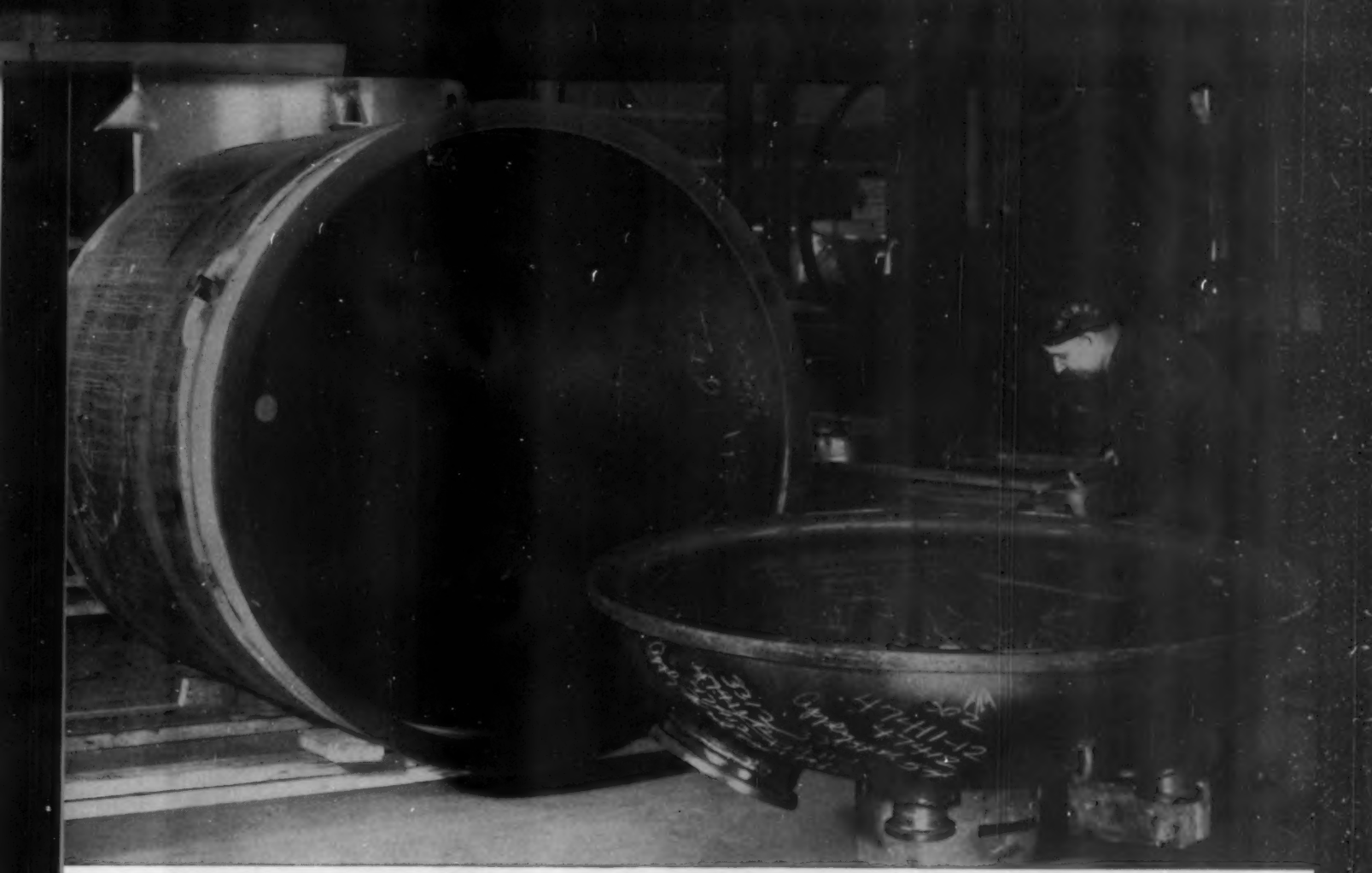


SSW forged ring flanges enable Pfaudler to increase pressure capacities of glass-lined tanks 50%

By switching to Standard Steel forged ring flanges for manholes and larger openings in their glass-lined tanks, The Pfaudler Company, Rochester, N.Y., has increased normal pressure capacities 50% above previous limits. These rolled, weldless flanges replace integral flanges formed in the tank wall or flanges formed from steel plate and welded to the tank shell.

Standard Steel forges these 24" to 84" ring flanges to heavier and more efficient shapes than Pfaudler could get previously. An increase in the flat surface area of the flanges permits increased pressures. The switch to forged flanges also has eliminated the serious problem of warping during annealing or stress relief before applying glass linings.

SSW shapes these rings as close as possible to finish dimensions in the rolling operation to minimize the amount of metal removed in roughing and finishing cuts. However, ample material is available for forming a bead on the edge of the flange to retain the clamps which hold the covers tightly on the gaskets.

Pfaudler's use of Standard Steel's weldless flanges is just one of the very diverse ways ingenious users are improving their products by switching to roll forged rings and flanges (12" to 144" O.D.). It'll pay you, too, to investigate how they can benefit you. For more facts please write to Department 8635, Standard Steel Works Division, Baldwin-Lima-Hamilton Corporation, Burnham, Pennsylvania.

Standard Steel Works Division

Burnham (Mifflin County), Pa.

BALDWIN-LIMA-HAMILTON

General Offices: Philadelphia 42, Pa. • Offices in Principal Cities

The disintegration of strontium 90 is used as the energy source. External radiation is within AEC tolerance limits.

One of the models of the battery is a multiple voltage source with taps at 1, 10, 100 and 1000 v and a current of 2000 micromicroamperes. Another supplies a voltage of 375 v at a current of 50 micromicroampere while the third model is a high voltage source supplying 10,000 v. Its current rating is 500 micromicroampere. This model is less than 5 cu in. in size. Patterson-Moos Div., Universal Winding Co., P. O. Box 1605, Providence, R. I.

For more information—
Circle 31, inside back cover

Reversing Drum Switch

This device is used for across-the-line starting and reversing of a-c polyphase or single-phase motors, or d-c motors. There is a choice of either "maintained contact" or "spring return to off" in the same switch. No tools are required for the simple conversion.

Nylon shaft bushings are used and current-carrying parts are heavy copper. The contacts are plated. Square D Co., 4041 N. Richards St., Milwaukee 12, Wis.

For more information—
Circle 32, inside back cover

Electronic Line Flow Switch

This device is made up of a control box and a remote coil. The coil is placed on a line close to the objects to be monitored but not in actual contact with them. When one of the objects comes within the field of the coil, the current flowing through the coil circuit is reduced, which in turn influences the internal circuit in the control box causing a microswitch to operate. This switch can be connected to any device such as a motor starter, a light or a horn.

The line flow switch operates on 110 v, ac, and will control 110, 220 or 440 v devices. Due to the fact that there is a 1 sec time delay arrangement in the circuit, objects moving past the remote coil do not influence the switch. However, when a metallic object pauses one second or longer within the field of the coil the circuit is actuated. This time delay can be either increased or decreased by the substitution of different values. Dudley Machinery Corp., Mountain View, Calif.

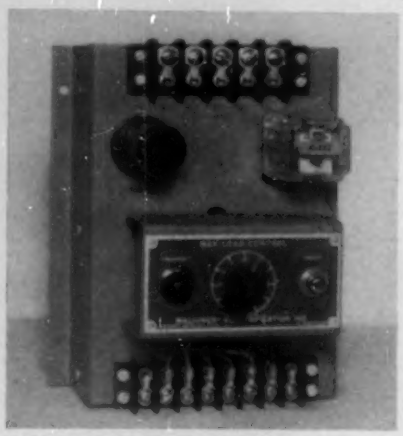
For more information—
Circle 33, inside back cover

Miniature Ceramic Rotary Switch

This switch occupies a panel area of less than 1½ sq in. Coin silver contacts, rotors and slip rings are provided for low contact resistance. Ceramic parts are silicone impregnated to withstand extreme humidity. Sturdy solder terminals are supplied for wiring.

The single-pole style has 18 shorting type contact positions available in many combinations. Two or three poles per deck may also be obtained. Flashover voltage at 60 cps is 1000 v peak and the current carrying capacity is 2 amp. Daven Co., Dept. SZ, 191 Central Ave., Newark, N. J.

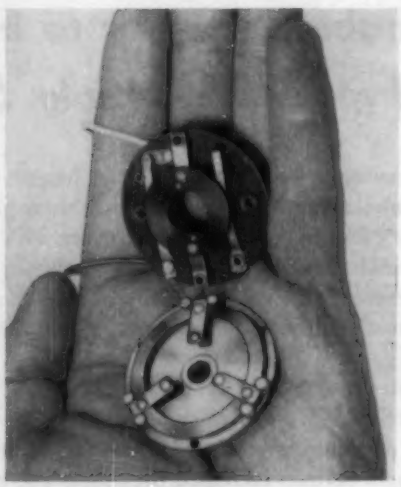
For more information—
Circle 34, inside back cover



Load Control Relay

This relay can detect an increase in input current to a machine or drive motor, and can also be used to correct the difficulty, stop the machine or process, adjust the feed or sound an alarm. Other models are available to detect load decreases, or changes both above and below desired limits. Machinery Electrification, Inc., Northboro, Mass.

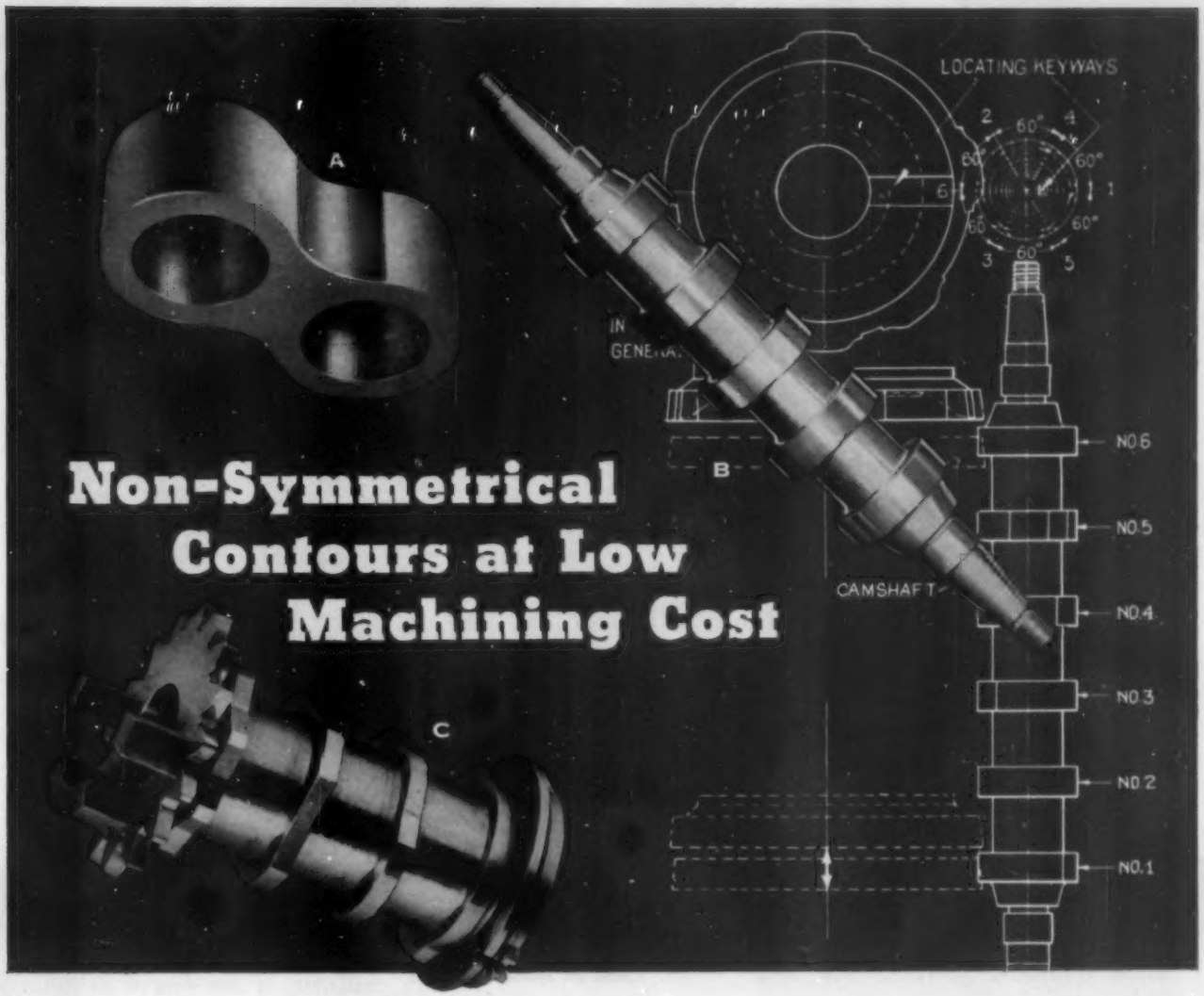
For more information—
Circle 35, inside back cover



Non-Fluttering High Speed Snap Switch

These switches are reported to be inherently balanced and are temperature compensated to assure precise operation at a predetermined speed over a wide temperature range. They can be used as an overspeed or underspeed limit control, or can be used in

—CONTINUED ON PAGE 232

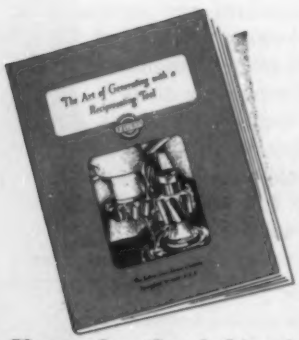


Non-Symmetrical Contours at Low Machining Cost

Molding-Generating commends itself to the shrewd designer. He can plan production on a *standard* Gear Shaper of odd contours for which multiple machining might otherwise be required.

A succession of different profiles can be precision-cut on a single piece (B & C above), often with several contours combined in one cutter. The variety is infinite—symmetrical and non-symmetrical forms, interrupted profiles – and on internal as well as external surfaces.

By simple adjustment and a change of cutters the Gear Shaper can be always busy on standard or special work. Know its versatility!



Yours for the Asking!

"The Art of Generating with a Reciprocating Tool". This booklet gives you detailed information on the design and machining advantages which are inherent in the Fellows Method. *Write for your copy today!*

THE Fellows GEAR SHAPER COMPANY

Head Office and Export Dept., 78 River St., Springfield, Vt.

Branch Offices: 319 Fisher Bldg., Detroit 2, Michigan • 5835 West North Avenue, Chicago 39, Illinois • 2206 Empire State Bldg., New York 1, N. Y. • 6214 West Manchester Avenue, Los Angeles 45, California

pairs to limit high as well as low speeds for a single application. They will detect rotational speed alone, regardless of voltage or load. They are presently furnished for any speed to 13,000 rpm. Torq Engineered Products, Inc., Interstate St., Bedford, Ohio.

For more information—
Circle 36, inside back cover

Speed Sensitive Switch

This three-element governor can be arranged to open or close three separate circuits at three different speeds anywhere between 1,200 and 10,000 rpm. Although all trip speeds are preset at the factory to customers specifications, any of the three trip points can be easily adjusted after installation.

The operating mechanism consists of rotating governor flyweights acting upon snap switches. This combination is said to eliminate the need for collector rings which are often troublesome, particularly at high speeds. The contacts are rated 10 amp at 115 v, ac. Synchro-Start Products, Inc., Skokie, Ill.

For more information—
Circle 37, inside back cover

Heat-Sensitive Relay

The glow of a cigarette at a distance of 10 ft, it is claimed, will actuate this relay. It can be used to actuate at a safe distance any device associated with high temperature operations. It is a self-contained unit providing relay action brought out to three terminals: common, normally-closed and normally-open. Maximum contact ratings are: 1) not more than 250 va, RMS, at any time; 2) not more than 5 amp immediately prior to opening; 3) not more than 500 v immediately prior to closing.

Cabinet is 9 x 12 x 6 in. deep. Dial can be mounted on front face or inside for setting actuation point. Power requirements are 115 v ± 10 per cent, 60 cps, 0.1 amp, one side grounded. Industrial Gauges Corp., Englewood, N. J.

For more information—
Circle 38, inside back cover

Interval Timers For 10 sec to 80 hr

A line of timers covering a time range of 10 sec to 80 hr is available in three models providing the measurement of one timed interval, two intervals or three intervals. These single and multiple circuit time controls are supplied already wired to operate varied types of programs. Aeronautical Mfg. Corp., Niagara Falls, N. Y.

For more information—
Circle 39, inside back cover

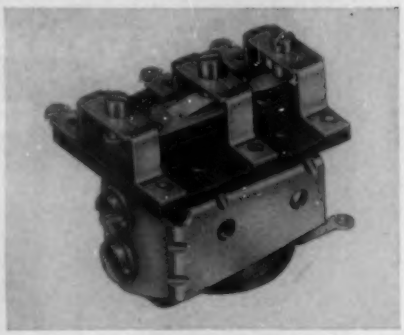
Rotary Reset Thermopilot Relay

A relay for automatic safety shutoff of gas-fired appliances, when used with an electric valve in the main line, provides 100 per cent shutoff, without reducing manifold capacity. A less expensive relay without pilot gas valve can be used when 100 per cent shutoff is not required.

The design of the relay assures safe lighting conditions and gives visual indication of the valve's position. When the knob is turned to off position, the gas flow to both the main burner and the pilot light stops immediately. There is no delay while the thermocouple cools down.

There are three models in the series, one with a bushing-type connection for the thermocouple, another a pilot generator, and a third, a double bushing type, for use with a limit control in the generator circuit. These relays carry full AGA and UL-approval and are furnished with either single-pole, single-throw or single-pole, double-throw wiring, or with special ignition contacts. General Controls Co., 801 Allen Ave., Glendale 1, Calif.

For more information—
Circle 40, inside back cover



Miniature Sensitive Relay

This relay occupies 1⅛ x 1$\frac{7}{32}$ x 1-¼ in. of space, and weighs 1½ oz in a single-pole, double-throw contact arrangement. The unit is set at the factory to operate on 10 milliwatt. The user can adjust it down to 2 milliwatt, or any desired pick-up or drop-out by means of fine screw contacts. A balanced armature provides extremely sensitive operation.

Three standard coil resistances are available: 4000, 6500, and 10,000 ohm. Maximum allowable coil rating is 3 w. Temperature range is — 55 C to 85 C. Units are available in open types, dust-tight or hermetically sealed enclosures. Advance Electric and Relay Co., 2435 N. Naomi St., Burbank, Calif.

For more information—
Circle 41, inside back cover

Motor Control Relay

This a-c relay is available in any standard arrangement of contact combinations from single-pole, single-throw, normally open, to double-pole, double-throw. Coil voltage of the unit is 115 v, 60 cps. Contacts are rated at 115 v, ac, 60 cps, single-

CONTINUED ON PAGE 234

'dag' dispersion stops scoring during run-in of light-weight compressor

Early in the production phase of a new light-weight aluminum compressor for the high-pressure pneumatic systems of aircraft, engineers of Walter Kidde & Company, Inc., Belleville, N. J. realized that special attention would have to be given to lubrication during run-in of the units. Tests of initial models showed that since oil film didn't have a chance to build up during the first few moments of run-in, pistons and cylinder walls were scored. This resulted in a high reject rate and expensive refinishing operations on first-stage pistons.

Kidde engineers have solved the problem by spraying finished pistons with undiluted **'dag'** Dispersion No. 213 before assembly of the units. The microscopically fine particles of colloidal graphite, dispersed in epoxy resin, form a tenacious bond with the metal surface after baking—provide a *dry lubricating film* that will not rub off during assembly and which prevents scoring and seizure during compressor run-in.

There are many other ways in which the dry-film lubrication provided by **'dag'** dispersions can help in the design and operation of all sorts of mechanisms, from toasters to turbines. Write for full information on **'dag'** Colloidal Dispersions for Dry-Film Lubrication, Bulletin No. 438-U8.

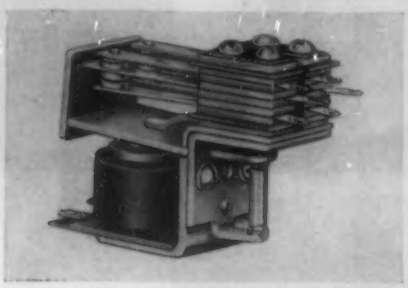
Dispersions of molybdenum disulfide are available in various carriers. We are also equipped to do custom dispersing of solids in a wide variety of carriers.

ACHESON COLLOIDS COMPANY

PORT HURON, MICHIGAN

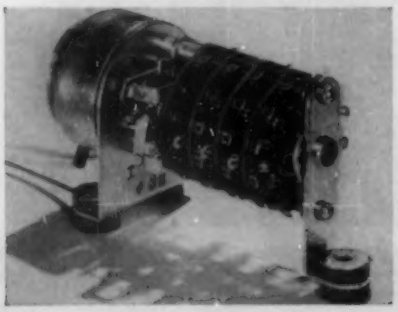
...also ACHESON COLLOIDS LIMITED, LONDON, ENGLAND

use 'dag' dry films for trouble-free lubrication



phase, ¼ hp. Standard coil and contact terminals are lug-type, tinned for easy soldering. Insulation of the contacts is tested at 1500 v, 60 cps. Guardian Electric Mfg. Co., 1621 W. Walnut St., Chicago 12, Ill.

For more information—
Circle 42, inside back cover



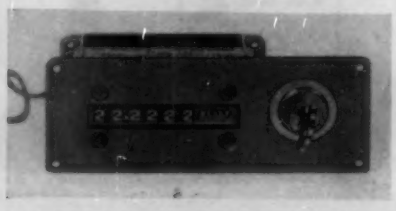
Relay Powered By Rotary Solenoid

A relay, 4 x 2-⅜ in. high, has an indexing lock which prevents misalignment of contacts and enables it to withstand a wider range of rotary solenoid power. The manufacturer claims it will meet the military vibration requirements under Procedure 1, specification MIL-E-5272A for frequencies up to 500 cps and 10 G, when properly mounted. The new relay is powered by a rotary solenoid. G. H. Leland, Inc., Dayton, Ohio.

For more information—
Circle 43, inside back cover

Tamper-Proof Electric Counter

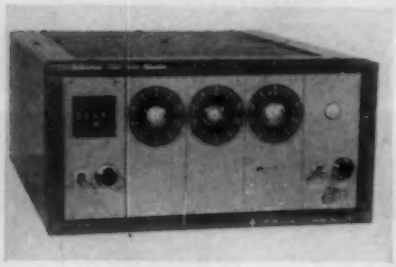
This counter is designed for panel mounting, and comes equipped with mounting plate, the lock reset being at the right of the plate. The entire assembly can be placed into a panel



directly from the front and securely fastened from the front.

Overall dimensions are: 5½ in. long, 2-9/16 in. deep and 2-1/8 in. high. Hardened steel working parts are used throughout. The operating speed is up to 1000 counts per minute. Standard voltage is 110 v, 60 cps, ac. Voltage fluctuations on normal industrial circuits have no effect on the accuracy of this unit. Durant Mfg. Co., 1938 N. Buffum St., Milwaukee 1, Wis.

For more information—
Circle 44, inside back cover



Totalizers for High Output

The maximum counting rate of 4000 counts per sec (or 240,000 counts per min) is achieved through a combination of low-heat, cold-cathode glow transfer counting tubes and an electro-mechanical register. Pulse pair resolution is 250 microsecond and total count capacity is seven digits (9,999,999). Counters are built from the unitized functional plug-in strips.

The counter is actuated from pick-ups which can produce a single 10-v pulse of either positive or negative polarity for each event to be counted. These may be of the magnetic, piezo-electric, photo-cell, acoustic, pressure or strain sensitive, or contact closure types. Model 8003 is 13 x 5½ x 12½ in., and is available as a bench instrument or with wing brackets for rack mounting. Tippett and Co., Inc., 419 Commonwealth Avenue, Boston 15, Massachusetts.

For more information—
Circle 45, inside back cover

Counts To 100,000 In 1 sec

This meter counts up to 100,000 in 1 sec with an accuracy of ±1 count. A crystal controlled timing circuit, said to be accurate to 0.001 per cent at room temperatures, gates the second counter for a 1 sec time interval. The count is directly displayed on the faces of direct-reading decade scaler tubes. When required, the instrument may be provided with an automatic reset circuit.

A total of 10 plug-in decade counters is used, each employing the new type direct reading decade scaler tube. The complete instrument with self contained power supply is for rack mounting. Ransom Research, P. O. Box 382, San Pedro, Calif.

For more information—
Circle 46, inside back cover

Remote-Indicating Counter

This unit is asserted to be capable of displaying with high accuracy counts of 3600 per min, actuated over a pulsing circuit of any reasonable length using either line or low voltage. The counting mechanism is a circular concentric-dial unit with radial hands and a low-inertia drive designed to minimize carry-over and multiple-count errors.

The counter will contain 999,999

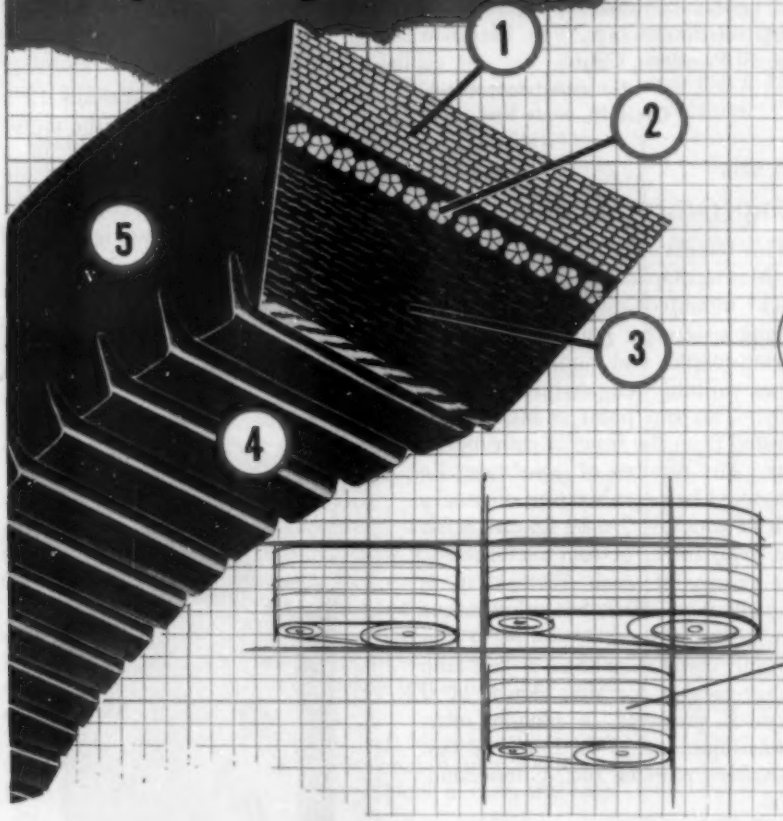
CONTINUED ON PAGE 236

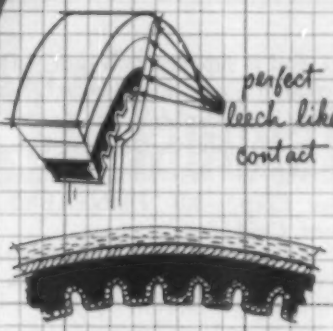
You get

40% more Power

for your drive design with

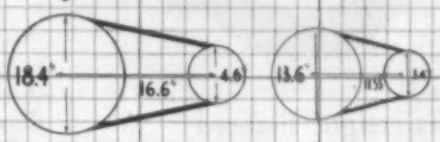
Dayton Cog-Belts*





SMOOTH, DIE-CUT SIDES GRIP SHEAVE GROOVES TIGHTER, GIVE MAX COEFFICIENT OF FRICTION. PREFORMED, BUILT-IN COG ELIMINATES BELT BUMPING OR INCHING AROUND THE SMALLEST SHEAVES.

Cog-Belts save space and weight



"B" CROSS SECTION 4 TO 1 SPEED RATIO COG-BELT DESIGN EFFECTS A 30.6% SAVING IN CENTER DISTANCE — A 26% SAVING IN WEIGHT — A 47.2% SAVING IN DRIVE AREA.

40% BONUS POWER PERMITS DESIGN FOR NARROWER SHEAVES, FEWER GROOVES SAVES WEIGHT, SPACE AND COST, PERMITS USE OF SHEAVES WITH 25% SMALLER DIAMETERS AND SHORTER CENTERS.

With the exclusive and patented Dayton Cog-Belt, made only by Dayton, available horsepower is increased by 40% per belt. One of the reasons is because its smooth die-cut sides, precisely angled for ideal contact in the sheave, provide greater gripping power and give maximum coefficient of friction without distortion. And in addition, you can also save on weight, space and cost without sacrificing one iota of construction or application advantages to gain this higher horsepower rating for your design.

Check These Exclusive Design Advantages:

1—The Tension Section flexes easily without cracking, straining or loss of life. **2**—The Load Carrying Section has maximum stretch-proof strength. **3**—The Compression Section has cross-wise rigidity. Patented Stiflex composition prevents squashing, buckling, binding. **4**—Preformed, integral Cogs flex uniformly for full grip . . . another Dayton patented exclusive. **5**—Smooth, die-cut sides assure positive grip, *full* power.

These exclusive design advantages of Dayton Cog-Belts provide flexibility in solving the most difficult drive problems. Because the longer-lasting Cog-Belt permits designs for shorter center distances, narrower sheaves, fewer grooves and fewer belts, you save weight by as much as 28%, save space up to 25% and save original belt cost.

For specific help on your drive design problem, write to: Dayton Rubber Company, Industrial Division, Dept. 873, Dayton 1, Ohio.

D.R. 1955 *T.M.

GOLDEN JUBILEE

Dayton Rubber 50 YEARS OF PROGRESS

World's Largest Manufacturer of V-Belts

counts, and is supplied as a unit with the counter and impulse receiver mounted in a slant-front metal box with two rear-mounted terminals for connection to the pulsing circuit. Raycon Corp., 301 Harbor Blvd., Belmont, Calif.

For more information—
Circle 47, inside back cover

Watertight Elapsed Time Indicator

This 3½-in. meter has five digit counters which can be provided to register 1/10 hr increments to 9999.9, or hour steps to 99999. Self-starting synchronous motors are used for 110-125 v, 60 or 400 cps, ac. They can operate continuously from — 55 C to 85 C. DeJUR-Amsco Corp., 45-01 Northern Blvd., Long Island City 1, N. Y.

For more information—
Circle 48, inside back cover

Motor Speed Control

This control is designed to provide stepless, reversible, adjustable speed operation of d-c shunt-wound motors rated up to 1/15 hp. It operates directly from existing single-phase a-c power lines and maintains constant torque over a wide speed range. Standard d-c motors can be operated through a working range of several hundred to one, while small motors with base speeds of 5,000 to 10,000 rpm can be used through a speed range of as much as 1000:1.

The new control is contained in a steel cabinet 7¼ x 6¼ x 4½ in. deep. Opad Electric Co., 69 Murray St., New York 7, N. Y.

For more information—
Circle 49, inside back cover

Turns-Counting Dial

This dial, 2 in. dia, provides 25 and 40-turn count-capacities for setting and indicating the revolutions of multi-turn components. It is made of black finished metal with raised and silvered divisions and numerals. Total weight is 3 oz. The dial is available from stock and is suitable for use with any multi-turn unit having a ¼ in. shaft. Helipot Corp., 916 Meridian Ave., S. Pasadena, Calif.

For more information—
Circle 50, inside back cover

Temperature Monitor

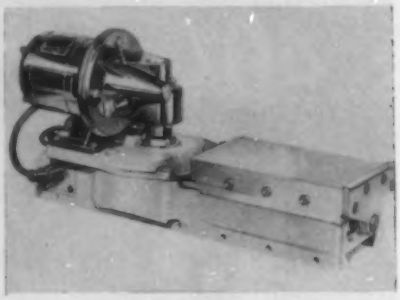
This temperature monitor, designed for bearing applications, is internally shock mounted and sealed. Each bearing or danger point has its own thermo-couple and indicator which shows running temperature continuously. The trip point is individually adjusted from the front of each meter-relay. Any number of points can be monitored by a combination of panels, each of which is 7 x 19 in. and holds one, two, three, or four meter-relays. The range of each meter-relay is normally 0 to 300 F, but other ranges may be substituted.

Each installation has a 50 amp circuit breaker for shut down, or if alarm is preferred, a plug-in relay. Power input is 115 or 230 v 60 cps. Assembly Products, Inc., Chesterland, Ohio.

For more information—
Circle 51, inside back cover

Cam-Controlled Cycling Feed

Cam-controlled automatic feed cycles for metalworking operations are provided by a cycling powered feed unit. This self-contained device consists of a slide assembly, feed mechanism, can drive motor and housing. Any desired tooling set-up may be mounted on the slide by the user. The equipment is practical for drilling, tapping, boring, reaming, sawing, milling, broaching and other precision work on parts of relatively small size. Cams for controlling the feed



cycle can be made by the user or supplied to order.

The new feed unit measures 17 x 6 x 8⅛ in high to the top of the motor housing. It can be mounted in a horizontal or vertical plane, or at any angle. Installation is completed by fastening two socket-head cap screws and connecting 110 v, a-c service. Russell T. Gilman, Inc., 1243 Milton Ave., Janesville, Wis.

For more information—
Circle 52, inside back cover

Circuit Protector for Home Appliances

These circuit protectors are engineered for single-hole mounting. The MP-252 furnishes permanent push-button protection for 15, 20 and 30 amp units. The MP-600 for 4 to 30 amp circuits.

Manual reset and trip-free operation are standard features. Appliances are positively protected against excessive overloads and short circuits. Service can normally be restored (after harmless overloading or "shorts") within

CONTINUED ON PAGE 238

You can simplify purchasing . . . improve design . . . speed production

with improved C-D-F DILECTO® laminates

Only C-D-F, the Continental-Diamond Fibre Company, makes Dilecto laminated plastic, just as only Cadillac makes a Cadillac. Dilecto is 50 different materials with more combinations and variations in desired properties than we can tell you here.

But Dilecto has three important qualities that you should think about if you buy, design, or machine laminated plastics.

DILECTO HAS HIGH MECHANICAL STRENGTH

Mechanical strength is frequently an important determining factor in the selection of an insulating material. Insulating parts used in large electrical power equipment are frequently bulky. The high mechanical strength of Dilecto helps reduce size-dimensions of insulating parts without danger of failure. Instruments, meters and small motors frequently require very small insulating parts which must withstand comparatively large mechanical stresses. Insulation for use in high frequency circuits should have a minimum bulk factor for minimum dielectric losses. Dilecto fulfills these requirements with a combination of high mechanical strength and low loss factor, characteristic of the better C-D-F electrical grades.

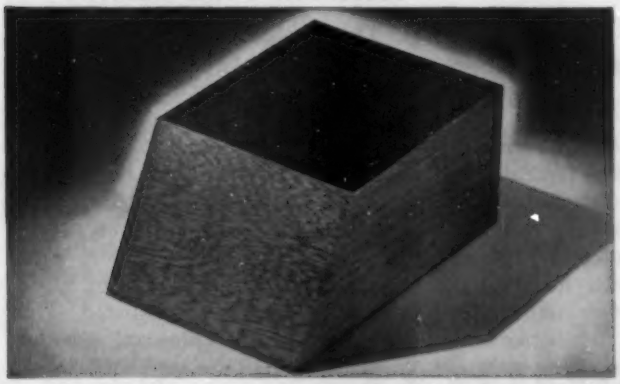
So C-D-F selects for your Dilecto insulation grade the correct, highest quality base material, paper, cotton, nylon, glass. These are used in combination with improved penetrating resins: Improved Phenolic, New Melamine, New Silicone, New Teflon, all synthetic, well polymerized resins.

Both the base and the resin are good insulators by themselves. But C-D-F sells them to you in an improved, practical form . . . Dilecto. Uniform sheets, tight tubes, strong rods, close tolerance machined and formed specialties, high bond strength metal clads.

Why does Dilecto combine so well mechanical strength with dielectric strength and dimensional stability? Because Dilecto is almost homogeneous, a true blend of resin and base.

DILECTO IS ALMOST HOMOGENEOUS

A poor laminate absorbs moisture at its edges, loses its insulating properties fast. Entrapped moisture and other volatiles within the cured structure causes inconsistent dielectric strength, with ultimate puncture and breakdown.



Punch press and bench saw operators know how much time and material is saved when the laminated plastic is *uniform* and *homogeneous* in nature like Dilecto.

DILECTO IS IMPROVED

Yes, C-D-F Dilecto is an improved laminated plastic, due to high standards and advances in resin and manufacturing techniques. It is watched by skilled workers in our modern plants, checked against rigid standards . . . C-D-F standards . . . by our quality control people. It is easy to machine, and the C-D-F shops are doing a booming business in specialties.

Table I—Typical Improved Phenolic Laminates

Commercial designation[a]	Resin	Filler	Improved properties	Improvement due to:
MEC-5	Phenolic	Nylon fabric	Insulation resistance; moisture resistance	Filler
XXHV-2[b]	Phenolic	Paper	High dielectric strength parallel to laminations	Resin and manufacturing technique
CRD	Phenolic	Cotton mat	Better machining	Filler
XXXP-26[b]	Phenolic	Paper	Insulation resistance; moisture resistance	Resin and manufacturing technique
C-92	Xylenol[c]	Cotton fabric	Alkali resistance	Resin
CF	Modified phenolic	Cotton fabric	Postforming	Resin

[a] All grades are Continental-Diamond Fibre Company.
[b] Resins have improved penetrating properties and the manufacturing techniques use these properties to provide better impregnation of the filler. Since thorough impregnation eliminates entrapped moisture and air, greater moisture resistance and better dielectric properties are attained. Manufacturing techniques also provide suitable temperature control during the curing stage to assure uniform quality and optimum property values in the finished laminate.
[c] Xylenol is essentially a dimethyl phenol.

—from Electrical Manufacturing Article "Wider Design Opportunities with the NEW Phenolics", Part II.

The next time you think of laminated plastics, the name to remember is C-D-F Dilecto. The improved, high strength, uniform material that makes insulation buying and using more a science, less a puzzle. New grades, new applications, new savings are just part of the Dilecto success story. Look up the facts in Sweet's Design File, or write for catalog. Send us your blueprint for quotation . . . tell us your design dream . . . C-D-F wants to work with you.

Continental-Diamond Fibre
CONTINENTAL-DIAMOND FIBRE COMPANY
NEWARK 40, DELAWARE

10 sec, yet the new protectors will not maintain a circuit that has not been cleared. Mechanical Products, Inc., 1840 River St., Jackson, Michigan.

For more information—
Circle 53, inside back cover

Hermetically Sealed Temperature Control

The snap-acting disc is located opposite the terminal and at the bottom of the metal enclosure, where temperature of air liquids or mounting surface can be followed. These controls are available in preset temperature settings. Differentials between opening and closing temperatures may be 15 deg and higher. They withstand temperatures 60 to 250 F (125 to 250 v); 250 to 400 F is available for ratings to 30 v, ac-dc. Spencer Thermostat Div., Metal & Controls Corp., Attleboro, Mass.

For more information—
Circle 54, inside back cover

Liquid Proportioner-Dispenser

This automatic device injects liquids into water in what are described as very accurate proportions. The liquid may be a soluable oil as used on machine tools, for example, or a chemical solution. The machine requires no outside power connection of any kind. It is so constructed that the solution being dispensed remains the same regardless of changes in water pressure or rate of water flow.

The Model R-3 (¾ in. pipe size) will take all water that will flow through a ¾ in. pipe line, up to 10 gpm. Pressure drop through machine is 5 to 15 psi, depending on rate of water flow. Model R-8 (2 in. pipe size) will take all water that will flow through a 2 in. pipe line, up to 100 gpm. Smith Precision Products Co., 1135 Mission St., S. Pasadena, Calif.

For more information—
Circle 55, inside back cover

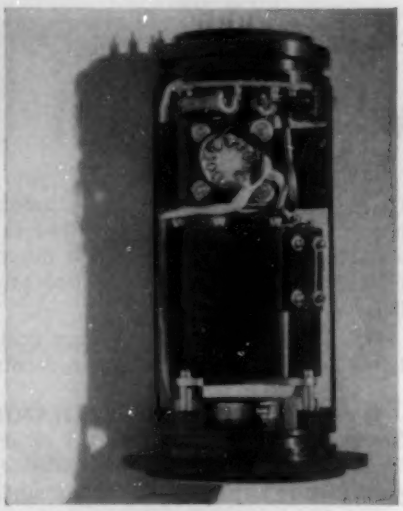
Machine Safety Guard

This equipment consists of a projector and a receiver mounted opposite each other on the machine. Light is projected in front of the danger zone of the machine. As long as this light is unobstructed, the receiver keeps a relay energized. If the operator blocks the light, the relay drops out, having the same effect as pushing the stop button. Should a tube burn out or be shorted or any other component fail, then the relay opens, stopping a machine just as if the light had been interrupted. This guard, therefore, "fails safe." Both 1 and 2 in. dia beams are obtainable. Maximum distance between projector and receiver is 20 and 80 ft, respectively. Light curtain is 7 or 12 in. high. Electronic Control Corp., 1573 E. Forest Ave., Detroit 7, Mich.

For more information—
Circle 56, inside back cover

Pressure-Operated Potentiometer

This transducer unit is for applications where the output voltage is to be a non-linear function of pressure. It consists of a precision ruggedized pressure-operated potentiometer having taps and provision for resistance loading across the winding. The mechanism operates in a hermetically-sealed evacuated container inside of the instrument case. A resistor board



designed to accommodate loading resistors is outside the case and may be reached by removing the outside cover. This feature permits the user to select any desired voltage ratio versus pressure function by installing loading resistors on the instrument's terminal panel. The instrument can be made linear with respect to altitude, air speed and other aerodynamic functions.

The potentiometer wiper moves linearly with pressure over the range 3.42 to 30.36 in. Hg (-400 to 50,000 ft) At 50,000 ft, the device has a time constant of 2 sec. The resistor board will accommodate up to six precision wire wound resistors which may be connected to any of six taps on the potentiometer winding. Trans-Sonics, Inc., Bedford, Mass.

For more information—
Circle 57, inside back cover

Electronic Press Control

This electronic fail-safe press control is designed to be installed on any press stamping operation where the stamped part may be directed from the press through a detection coil; where the press cycle can be made to stop at the top of its travel as it completes 360 deg revolution or can be made to stop just before press punch enters the lower die, and where the press is electrically initiated. This unit (with its detection coil mounted in such a position as to allow ejected parts (ferrous or non-ferrous) to pass

CONTINUED ON PAGE 240

Here's an exciting new development in metallized ceramics!

NICOTE METALLIZED CERAMIC COATING

for use with both hard and soft solders!

Here is Frenchtown's revolutionary answer to a problem that has baffled industry for years . . . a satisfactory *single* metallic coating for refractory ceramic bodies which provides a surface for applying solders with melting points between 275° and 1600°.

NICOTE, applied to refractory ceramic bodies by high temperature firing, in most applications requires no expensive preliminary processing such as buffing, electroplating, or tinning to form a strong, firmly-adhering bond with either *hard* or *soft* solders.

Whether the problem requires the fastening of a metal part or other metallized ceramic parts to its surface, NICOTE offers distinct advantages over ordinary silver soft receptive coatings as well as molybdenum and tungsten hard solder coatings. It will withstand molten soft soldering *indefinitely* . . . it's less costly to produce . . . requires no expensive processing.

NICOTE'S mechanical bond to the refractory ceramic body approximates ceramic strength, making it ideal for hermetic seals, high strength mechanical seals, and vacuum type applications.

Like to know more about the amazing possibilities of NICOTE Metallized Ceramic Coating for your product? Bulletin 155 contains complete engineering details. Write for a free copy today. There's no obligation, of course.

This idea starter is free for the asking . . . contains complete facts and details about NICOTE . . . Frenchtown's new **single metallic coating** for use with **both** hard and soft solders. Ask for Bulletin 155.

frenchtown PORCELAIN COMPANY

87 MUIRHEAD AVENUE | TRENTON 9, NEW JERSEY

through) watches the recycling operation so that the dies will not double-head on a non-ejected part.

This control unit may also be used to recycle the press so that the instant the stamped part is ejected clear of the dies, the press is immediately recycled.

The control is composed of an electronic fail-safe timer with electronic detection coil circuits. The unit is enclosed in a 6½ x 10½ x 12 in. shock-mounted cabinet. A shielded 10-ft long, three-wire cable is used for connecting the electronic unit to the detection coil. Input voltage required is 115v 60 cps. Timing relay has normally open contacts rated at 3 amp at 110v. Robotron Corp., 21300 W. 8 Mile Road, Detroit 19, Mich.

For more information—
Circle 58, inside back cover

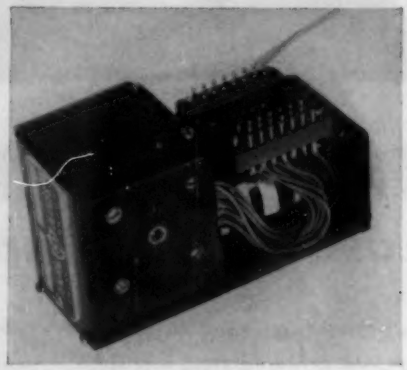
Springdriven Stepping Switch

This stepping switch can function as either an 11-point or a 10-point switch. It is capable of a wide variety of applications, such as: 1) selecting any desired point in a series; 2) selecting the first unoccupied point in a series; 3) sequence controlling—automatically controlling a series of operations in a predetermined manner; 4) counting and totalizing; 5) generating timed impulses; 6) monitoring.

The new switch may have from one to eight bank levels of ten or eleven points each. Each bank level is traversed by a pair of wiper springs. The rotor is driven by a durable stainless-steel ratchet wheel having 33 teeth. Wipers can be arranged so that the several bank levels can be used independently to secure 10-point or 11-point operation, or in tandem to secure up to 33-point operation.

Overall length of the switch is only 4-13/32 in. including mounting bracket. The height is 2-5/16 in. and the width with eight levels is 2-1/8 in. C. P. Clare & Co., 3101 Pratt Blvd., Chicago 45, Ill.

For more information—
Circle 59, inside back cover



Sampling Switch With 5 cps Motor

A high-speed sampling switch for telemetering, data recording and related applications has two synchronized poles and 30 contacts per pole. Fifteen alternate contacts and collector rings are provided per pole, tied to individual plugs. Length, excluding screws, is 3-7/16 in. General Devices, Inc., Princeton, N. J.

For more information—
Circle 60, inside back cover

Transistor-Magnetic Servo Amplifier

This is a combination silicone transistor-magnetic servo amplifier. The unit will deliver full power to the parallel connected control windings of 400 cps BuOrd MK7 or MK14 servo motors.

The overall voltage gain, when driving the MK7 motor, is greater than 2000. This very high gain, coupled with the wide bandwidth of 0 to 70 cps, makes this unit a very useful component in instrument servo systems. The use of silicone-type transistors for the preamplifier allows operation at ambient temperatures up to 85 C. Polytechnic Research & Development Co., Inc., 202 Tillary St., Brooklyn 1, N. Y.

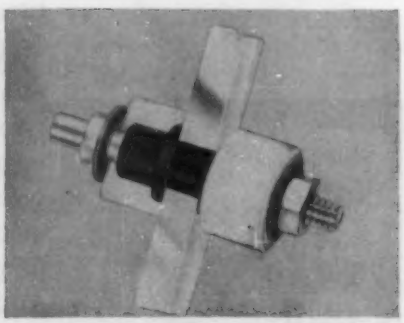
For more information—
Circle 61, inside back cover

Parallel Slot Grounding Receptacle

The new UL-requirements eleminating the pigtail for grounding on line cords appears to make the three-prong, parallel blade layout the most popular substitute for the 110v, 15 amp line cord applications. A miniature, three-wire outlet uses an adapter plate to provide this third contact. This adapter plate slips over this manufacturer's standard outlets. It takes no more space than is generally used with conventional two-contact, parallel slot, a-c outlets.

The new grounding outlets are available with solder tabs. They are available with leads tailored to the customer's specification by specifying lead lengths. Alden Products Co., 117EE N. Main St., Brockton, Mass.

For more information—
Circle 62, inside back cover



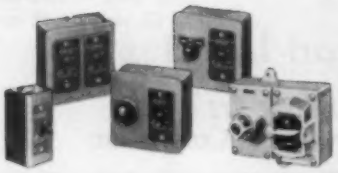
Heavy-Current Hermetic Terminal

The design at this terminal is said to feature critical hermetic sealing, high current capacity and high voltage ratings, with excellent resistance to thermal and mechanical shock. It is a ceramic, compression-type, anchored-gasket unit, with neoprene or silicone rubber as the sealing member. Current capacity is 100 amp, with a voltage rating of 5000v. The terminal

CONTINUED ON PAGE 242

THE ALLEN-BRADLEY LINE

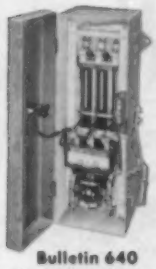
MANUAL CONTROLS — DRUM SWITCHES — REDUCED VOLTAGE



Bulletin 600
Starters for frac. hp motors. Automatically stop overloaded motors

Bulletin 609
Manual across-the-line starter

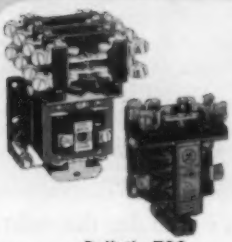
Bulletin 350
Wide variety of drum controllers up to 500 hp



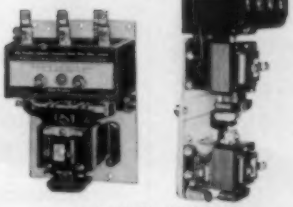
Bulletin 640
Manual resistance starter

Bulletin 646
Manual autotransformer starter

AUTOMATIC CONTROLS — SOLENOID STARTERS — COMBINATION STARTERS

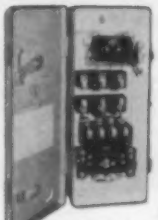


Bulletin 700
Over 300 types of solenoid relays—1 to 8 poles

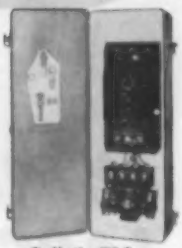


Bulletin 702-704
Full line of solenoid contactors in 9 sizes up to 900 amperes

Bulletin 709
Starters up to 300 hp, 220 v; 600 hp, 440-550 v

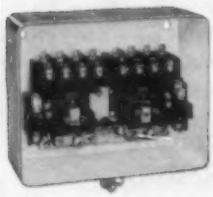


Bulletin 712
With manual disconnect

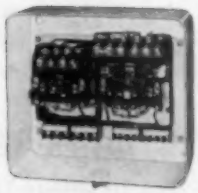


Bulletin 713
With circuit breaker

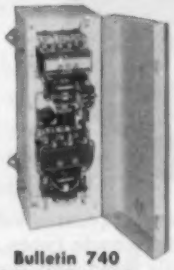
AUTOMATIC CONTROLS — RESISTANCE STARTERS — AUTOTRANSFORMER STARTERS



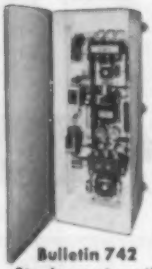
Bulletin 705
Reversing switch with overload relays



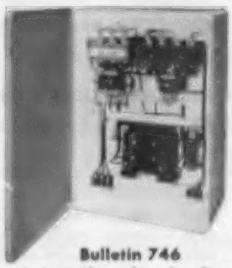
Bulletin 715
Multi-speed starters for 2, 3, & 4 speeds



Bulletin 740
2-Step automatic resistance starter



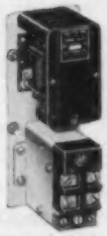
Bulletin 742
Stepless automatic resistance starter



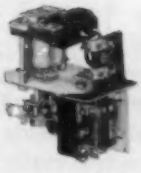
Bulletin 746
Automatic reduced voltage autotransformer starter

ACCESSORIES — LIMIT SWITCHES — PUSH BUTTONS

Bulletin 848
Dashpot timer

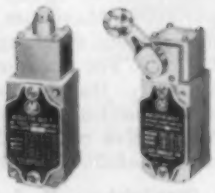


Bulletin 849
Pneumatic timer

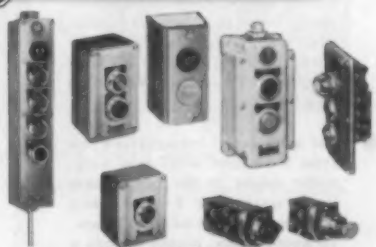


Bulletin 850
Motor-driven timer

Bulletin 802
Limit switch



Bulletin 802T
Oiltight limit switches



Bulletin 800-800T Push Buttons
Hundreds of standard, heavy duty, and oiltight push buttons, and pilot lights

For complete information on the Allen-Bradley line, please write for the A-B 120-page Handy Catalog.

ALLEN-BRADLEY
SOLENOID MOTOR CONTROL
QUALITY

Write to
Allen-Bradley Co.
1329 S. First St.
Milwaukee 4, Wis.
In Canada—
Allen-Bradley Canada Ltd.
Galt, Ont.

EXTRA LARGE CAPACITY

New Pressure Actuated On-Off Valve... Low Cost Substitute For Solenoid Valves

TYPE D-53

- Also applicable wherever desireable to control line flow by use of independent pressure on the diaphragm. Type D-53 is finding wide acceptance in substitution for expensive Solenoid Valves.
- Full port means high capacity. All bronze housing. Renewable chrome plated valve seat and composition seat disc. Neoprene nylon diaphragm. Also available with adjustable maximum and/or minimum flow limit stops.
- For additional information on Type D-53, and other new automatic valves in the Cash-Acme line, write our Engineering Department at the address below. To avoid delay, please include a brief outline of your pressure conditions and requirements.

This new pressure operated valve is offered in two basic types... either normally open and *closed* by diaphragm pressure or normally closed, and *opened* by diaphragm pressure. Typical use is on water cooled compressors.

Type D-53 may be used to handle water, air, oil or any non-corrosive fluids. Maximum body pressure 250 psig; diaphragm pressure 300 psig. For maximum hookup flexibility, the diaphragm pressure connection on this new Cash Acme valve may be indexed to any of the following four positions:

1. Over inlet
2. Over Outlet
3. Right Side
4. Left Side

CASH ACME

A. W. CASH VALVE MANUFACTURING CORP.

6662 E. Wabash Avenue Decatur, Illinois

The Complete Cash-Acme Line Includes Pressure Reducing and Regulating Valves, Relief Valves, Back Pressure Valves, Vacuum Regulators and Vacuum Breakers. Differential Pressure Regulators, Strainers, Diaphragm Control Valves.

has an outside diameter of $\frac{7}{8}$ in. It is available with a single copper or brass conductor. Lundey Associates, 694 Main St., Waltham, Mass.

For more information— Circle 63, inside back cover

Miniature Precision Connector

These connectors have one-piece molded inserts to prevent moisture traps and electrical breakdown. Two shell sizes accommodate three, four or five contacts, or 15, 19, 27, 31 contacts for No. 20 AWG wire. DeJUR-Amsco Corp. 45-01 Northern Blvd., Long Island City 1, N. Y.

For more information— Circle 64, inside back cover

Miniature Hermetically Sealed Resistor

Measuring $\frac{7}{8}$ x $\frac{11}{16}$ in dia, this resistor can be soldered directly into the circuit with no support other than the wire leads. Maximum voltage is 2500. Maximum resistance value is 10 million megohm. Standard tolerance is 10 per cent. Resistance Products Co., 914 S. 13 St., Harrisburg, Pa.

For more information— Circle 65, inside back cover

High Temperature Film Type Resistor

It is claimed that these resistors can be used at 150 C at full rated power. They derate linearly to 0 at 190 C. The temperature coefficient is below 400 PPM per deg C, is always positive in value, and is independent of resistance value. The voltage coefficient is below 0.0005 per cent per volt. The new resistors are available in $\frac{1}{4}$, 1 and 2 w. Daven Co., Dept. RK., 191 Central Ave., Newark 4, N. J.

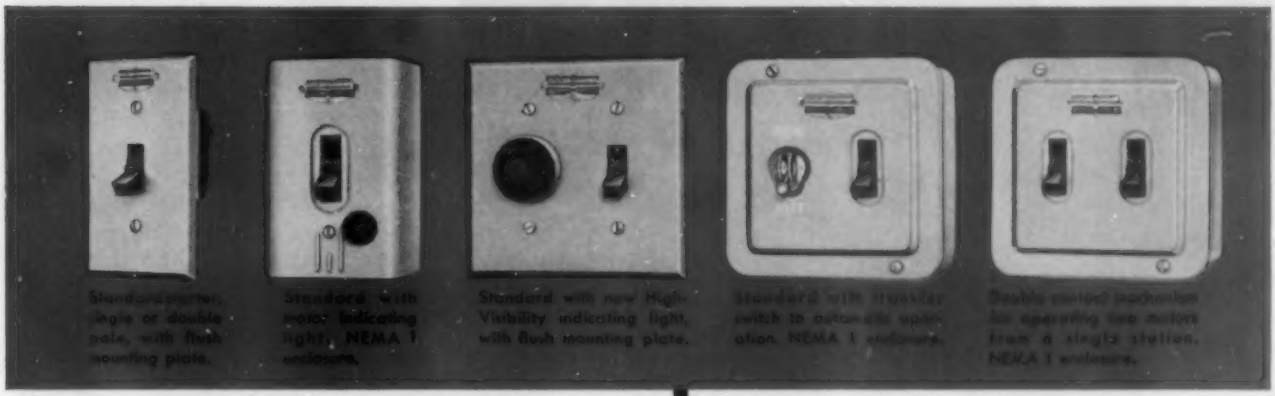
For more information— Circle 66, inside back cover

Miniature Mica Capacitor With Parallel Leads

Rated at from 1 to 510 mmf at 300 v, dc and up to 400 mmf at 500 v, dc, this capacitor provides minimum capacity tolerance of $\pm\frac{1}{2}$ per cent or 0.5 mmf (whichever is

Now-the 9101 "Family"

The Cutler-Hammer Line of fractional horsepower manual starters now includes new mechanisms, new styling, new uses



Standard starter, single or double pole, with flush mounting plate.

Standard with motor indicating light, NEMA 1 enclosure.

Standard with new High-Visibility indicating light, with flush mounting plate.

Standard with transfer switch to automatic operation. NEMA 1 enclosure.

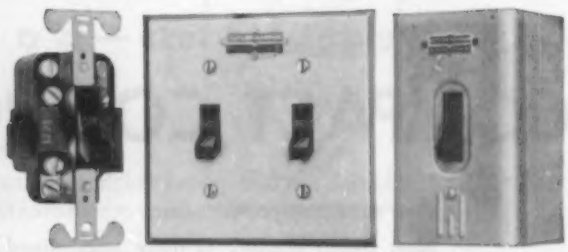
Double control mechanism for operating two motors from a single station. NEMA 1 enclosure.

In order to meet the ever-growing needs of the market with a starter of proven design, Cutler-Hammer now brings out a complete family of Bulletin 9101 Manual Starters for fractional horsepower motors.

This family now includes the standard starter with motor-running indicating light, with standard or with high-visibility lenses. It now includes a standard switch together with transfer switch to automatic operation with padlocking provision. It now includes a "2 in one" model, two starters in one case for controlling 2 motors from a single station.

Another feature of great interest is the optional brushed stainless steel flush plate for installations such as hospitals, modern office buildings, etc. Conventional finish is gray baked enamel on a bonderized undercoat.

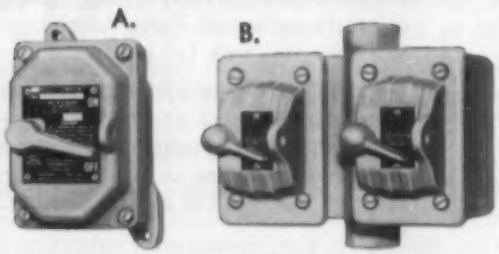
9101 starters are available for mounting in a standard Gem or Handy outlet box; for flush mounting; for surface mounting. The 9101 is a high-quality line at no premium cost. Its features include single or double pole, quick make and break silver contacts; eutectic alloy overload protection; straight-through wiring; wrap around covers, etc., etc. Available at your authorized Cutler-Hammer distributor. CUTLER-HAMMER, Inc., 1332 St. Paul Ave., Milwaukee 1, Wis. *Associate:* Canadian Cutler-Hammer, Ltd., Toronto, Ont.



Open type, mounting in Gem or Handy outlet box.

Skeleton starter with flush-mounting plate.

Enclosed surface mounting construction.



A. Starter in NEMA 7 or 9 Special Service Enclosures.

B. Duplex starter in NEMA 4 or 5 Special Service Enclosure.

CUTLER-HAMMER
MOTOR CONTROL
C-H

New Gast Model 0211 integral-motor Air Pump weighs 1/3 less — is a truly

COMPACT COMPONENT

In addition to a nine-pound weight reduction,* this new Gast rotary-vane Air Pump provides many other advantages.

New pump housing is more streamlined, more compact, better-looking! New G. E. Form "G" motor has pump rotor mounted on motor shaft, assuring smoothness and dependability. Light-weight sliding vanes provide positive, pulseless air delivery.

Resilient, rubber-cradled mounting dampens vibration and hush-quiets the entire unit. Pump delivers up to 1.3 c.f.m. running open at 1750 r.p.m., with 1/6 h.p. motor using only 3.8 amps.

Designed for original equipment applications, Model 0211 produces a maximum 25 p.s.i. or 27" vacuum — ideal for many automatic machines, industrial instruments and controls. Present O.E.M. uses include paper feeding in packaging, printing frames, liquid solvent agitators. Also used as a portable laboratory vacuum and pressure source.

Consider the advantages *your* product can derive from this new, compact component... *and write for Bulletin 1254 and "Application Ideas" Booklet!* **Gast Manufacturing Corp.**, P. O. Box 117-V Benton Harbor, Michigan.

*Now only 22 lbs.

Original Equipment Manufacturers for Over 25 Years

GAST ROTARY

- AIR MOTORS TO 4 H.P.
- COMPRESSORS TO 30 P.S.I.
- VACUUM PUMPS TO 28 IN.

SEE OUR CATALOG IN SWEET'S PRODUCT DESIGN FILE

greater) with remarkable stability over wide temperature range. Measuring $\frac{1}{16}$ x $\frac{3}{32}$ x $\frac{3}{32}$ in. to $\frac{1}{8}$ in. thick, all RMA and MIL-C-5 specifications for regular capacitors are met. Electro Motive Mfg. Co., Inc., Willimantic, Conn.

For more information— Circle 67, inside back cover

Polysterene Capacitor

This capacitor is designed for use as a charge storage capicitor and as a capacitance divider. Except for studs and aluminum foil winding, it is completely plastic.

The insulation resistance at room temperature is 30,000,000 meg x mfd at 400 v, dc. Condenser Products Co., 140 Hamilton St., New Haven, Conn.

For more information— Circle 68, inside back cover

High Temperature Capacitor

This capacitor is reported to have been run continuously for 17,000 hr. at 200 C and 140 per cent of rated voltage without deterioration. Average change in capacitance is less than 2 per cent after repeated cycling from room temperature down to −70 C, up to 200 C and back to room temperature.

Insulation resistances as high as 10^{16} ohms are available. Sizes range from 0.190 in. dia, $\frac{3}{4}$ in. length for 0.001 mfd capacity to 1.25 in. dia, $1\frac{7}{8}$ in. length for 0.500 mfd. Balco Research Laboratories, 40 Edison Pl., Newark 2, N. J.

For more information— Circle 69, inside back cover

Pressure Transmitter For Up to 100 Psi

Designed for industrial applications requiring an electrical output proportional to pressure, this instrument uses a pressure capsule that operates the wiper of a precision potentiometer in direct proportion to applied pressure. The device is available in ranges up to 100 psi, for absolute, gage and differential pressure measurements. The precision potentiometer uses precious metals in both winding and wiper for low friction, high resistance to corrosion, and long operating and shelf life. Outputs up

Announcing . . .

a portable, bench-type comparator for either horizontal or vertical projection . . .

the KODAK CONTOUR PROJECTOR, Model 8

Here's how Kodak brings you new economy in checking small parts by projection gaging:

Two-way staging: Parts can be staged in simple holding fixtures for horizontal projection on the Model 8. Or you can turn the machine on end for vertical projection and simply lay the workpiece on an easily mounted plate-glass stage. Only Kodak provides this choice to simplify your staging.

Choice of magnification: Six precision projection lenses (10×, 20×, 31¼×, 50×, 62½× and 100×) are quickly interchangeable, seat positively for precise rated magnification.

Large work area: Kodak's unique relay lens system gives you uniform, ample working distance at *all* magnifications.

Easily portable: The cast-aluminum Model 8 is easily portable, designed for use on bench or table.

Bright screen image: Coated lenses which increase light transmission—plus a special Fresnel lens back of the screen—yield a bright image, permitting you to use the Model 8 anywhere in the plant.

Optical stability: Kodak's famed Ektar Projection Lenses and rigidly built lens mounts and housings insure accurate performance year after year, provide precision equal to that of large toolroom projectors.

Easy to use: Operators learn inspection procedures quickly, using optical gaging on the Model 8. Erect, right-reading image with both vertical and horizontal projection cuts down training time. Air-cooled lamphouse and handy controls assure operator ease.

EASTMAN KODAK COMPANY
Special Products Sales Division
Rochester 4, N. Y.

the KODAK CONTOUR PROJECTOR

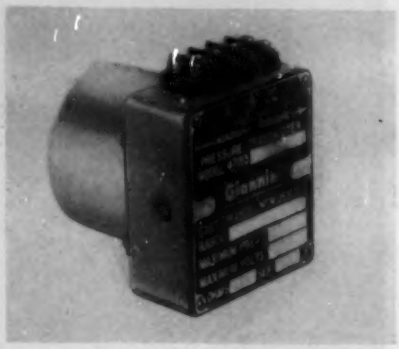
● If high heat loss or restricted cabinet space creates a cooling problem in your electronic equipment, it's time to talk to the engineers at Peerless Electric. Their experience in solving similar problems for leading electronic equipment manufacturers assures expert technical advice.

Peerless blowers and motors are job-matched for peak efficiency. Your own or government specifications for high or low temperatures, special finishes, winding treatments and space problems can be met. Your most complicated installation is standard for Peerless. Let's put our heads together. Our engineers will work with you to develop increased efficiency in less cabinet space.

Certified Ratings
PFMA

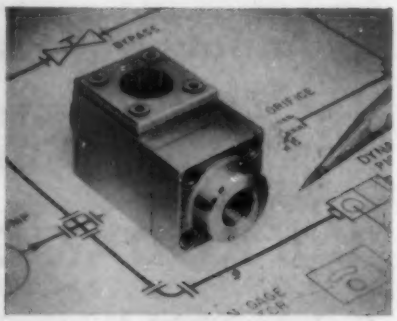
FAN AND BLOWER DIVISION
THE PEERLESS ELECTRIC COMPANY
FANS · BLOWERS · MOTORS · ELECTRONIC EQUIPMENT
1406 W. MARKET ST. · WARREN, OHIO

Peerless Electric



to 40 v can be obtained from this instrument and it can be used to operate indicating, recording or control devices with little or no amplification. Standard resistance is 2,000 ohm, with a power rating of 0.5 w. Accuracies to 0.8 per cent and sensitivity to 0.4 per cent can be obtained. The instrument is approximately 2.75 in. square and 3 in. deep. G. M. Giannini & Co., Inc., 918 E. Green St., Pasadena 1, Calif.

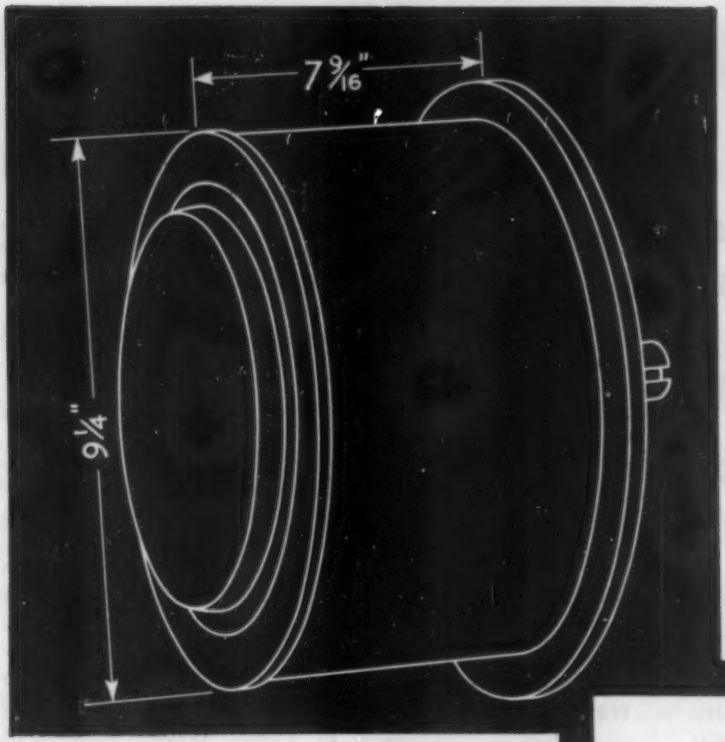
For more information—
Circle 70, inside back cover



Pressure Pickups for Up to 2000 Psi

These pickups consist of a flexible, pressure sensitive diaphragm held at its rim in a rigid case and connected by an actuating rod to a special, strain-sensitive resistance bridge. Separate input pressures are brought to bear on either side of the diaphragm through threaded connection holes provided in the ends of the case. An electrical output signal proportional to the difference between the two pressure inputs is brought out through a connector in the side of the case.

Models are available with differential pressure ranges of 0-10, 0-25, 0-50, 0-100, 0-300, 0-500, and 0-1000 psi. All units can be adjusted so that the operating range either straddles or falls to one side of a 2000 psi refer-



PANCAKE POWER

BY

Peerless®

A machine tool manufacturer asked us to build him a motor with 1 HP; 1,750 RPM; single phase to fit a 7-11/16" space in the base of his lathes. This is the motor. It is totally enclosed to seal out the dust and chips encountered under shop conditions. The motor answers the requirements in every respect and gives him top product performance.

Peerless Electric develops hundreds of motors for OEM use. Let us tackle your motor problem. Peerless teamwork engineering — our engineers working with your engineers — will produce the one motor that powers your products best.

ELECTRIC MOTOR DIVISION

THE Peerless® Electric COMPANY

FANS · BLOWERS · MOTORS · ELECTRONIC EQUIPMENT

1509 W. MARKET ST. • WARREN, OHIO

By Invitation Member

Emblem of BUSINESS CHARACTER

Rice Leaders of the World Association

Represents High Standing in NAME - PRODUCT - POLICY

Norgren

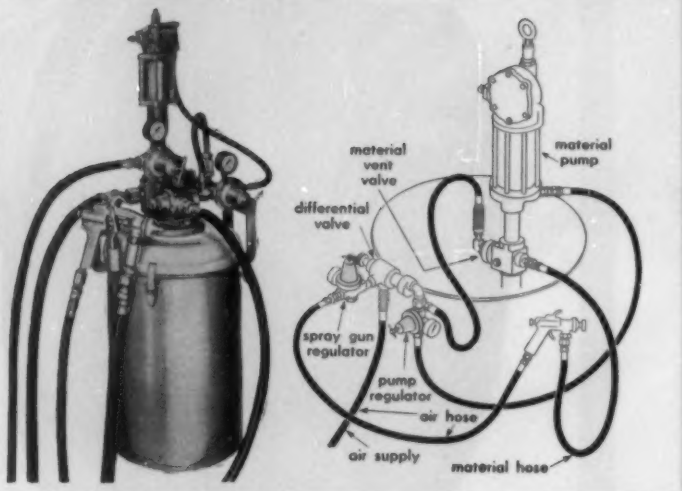
PRESSURE REGULATORS
selected by

LINCOLN ENGINEERING CO.

as standard equipment on
MATERIAL DISPENSING PUMPS

Their competitive tests proved that Norgren Regulators...

- **have a larger flow capacity at pressures up to 80 psi**
- **give better pressure control**
- **result in cost savings because ½" Norgren Regulators replaced ¾" units.**



The Lincoln Material Dispensing Pumps are air-powered units incorporating a 4" air motor and a balanced pump tube design which results in material flow on both upward and downward strokes. The problem was to obtain pressure regulators which would handle sufficient air flow for operation of pump, pressure flow equalizer and spray.

Extensive competitive tests resulted in the selection of Norgren Regulators which resulted in better performance and a saving in equipment costs.

Norgren C. A. CO.
3428 So. Elati, Englewood, Colo.

FOR COMPLETE DETAILS WRITE FOR NORGREN BLUEPRINT NO. 119

Oil Fog Lubricators • Pressure Regulators • Air Filters Valves • Hose Assemblies

ence figure. Pressure inputs to the pickup are made through ⅛ in. female pipe thread connections. Standard units operate with a-c or d-c excitation voltages of 6, 12, or 15 v, with bridge resistances of 350, 600 or 800 ohm, and minimum full-scale outputs of 20, 40 or 50 millivolts, respectively. Dynamic Instrument Co., Inc., 28 Carleton St., Cambridge, Mass.

For more information— Circle 71, inside back cover

Miniature Tantalum Capacitors

The anode of this capacitor consists of a porous, sintered tantalum body with a short length of tantalum wire which terminates in a nickel wire serving as the anode lead. The sealed, fine silver tubular case serves as the cathode to which the cathode lead is attached. Dimensions are $\frac{3}{32}$ in. dia. and $\frac{3}{4}$ in. length, and the temperature range is −55 C to 85 C. Cornell-Dubilier Electric Corp., S. Plainfield, N. J.

For more information— Circle 72, inside back cover

Force Balance Flow Transmitter

This transmitter measures differential pressures and transmits a 3 to 15 psi signal to a receiving, recording or controlling instrument over the entire range of 0-50 in. to 0-250 in. of water differential without change of parts. A silicone-filled capsule, with two pressure-sensing stainless steel diaphragms, automatically dampens and filters flow "noises" at the measurement source, yet permits high speed response to actual flow. Machined overrange stops are used for protection up to full 1500 psi rating of the instrument. The unit weighs 21 lb. Foxboro Co., Foxboro, Mass.

For more information— Circle 73, inside back cover

Low-Pressure Miniature Pickup

This pickup has low acceleration sensitivity as a result of the low mass of the sensing element. The type 4-315 is available in standard ranges of ±1, ±2, ±3 psi differential. It is

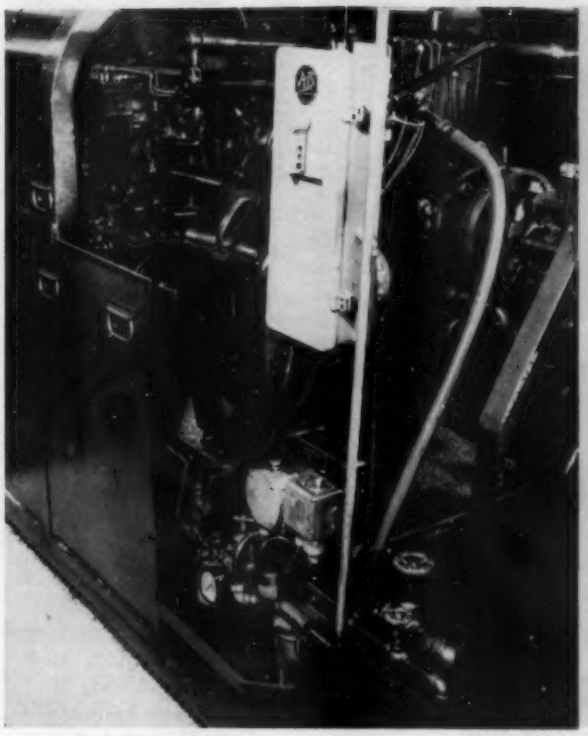
how a Lubrication Engineer converted to NORGREN MICRO-FOG LUBRICATION of an automatic screw machine

RESULTS:
- *increased life of bronze slide blocks*
- *½ pt. of oil does better job than 15 gal.*
- *reduced machine maintenance*

A 3000 rpm automatic screw machine, used by a leading manufacturer of electrical automotive equipment, was formerly equipped with circulating oil system and used 15 gallons of oil per day. There was a considerable oil loss due to splashing and to leakage from the bearings.

A Norgren Lubro-Control Unit (Model 3765AV-2) was installed to lubricate the sleeve bearings, anti-friction bearings, slide blocks, guides, chucking mechanism and gears.

results: *Just ½ pint of oil per day through the Norgren Micro-Fog Lubricator does a better lubrication job than 15 gal. of oil with the circulating system...life of bronze slide blocks was substantially increased...machine maintenance was noticeably less.*



An Automatic-Drain Air Filter (Model 11,200-2(25)) prevents contamination of oil supply; a Regulator (Model 2A2GG) reduces main line pressure to proper working pressure; a Lubricator (Model 30-41-2S) delivers an air-borne Micro-Fog to all bearing surfaces. A solenoid valve starts and stops the Micro-Fog system when the machine is turned on and off. A pressure switch turns off the machine automatically when air pressure drops below a safe operating value.

designers... you can add many important operating features to your machine tools with Norgren Micro-Fog Lubrication...types and sizes of lubricators for both small and large machines, with capacities up to 1000 bearing inches.

For details on the above and other machine tool applications and technical information on system design, write for Norgren Blueprints MF10 through MF18

C. A. Norgren CO.
3428 So. Elati, Englewood, Colo.

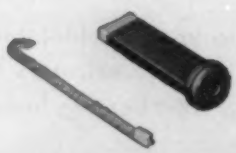
Pioneer and Leader in Oil Fog Lubrication for 27 Years

Oil Fog Lubricators • Pressure Regulators • Air Filters • Valves • Hose Assemblies

Our staff must be contantly alert to the changing requirements of the electrical industry. Yet quality must be maintained in spite of the unusual demands. That's why our technical men meet often — much more often than you would suppose, probably — to keep every Superior brush, contact, or powdered part uniform in quality year after year.

CONTACTS OF PRECIOUS AND BASE METALS
—as you want them

- contact assemblies
- contacts brazed to your assemblies
- contacts



Illustrated at the left is just one of our services, but it shows how we must be able to supply contacts as you want them. Call on us also for help with mechanical carbons and powdered metal specialties.

SUPERIOR CARBON PRODUCTS, INC.
9115 GEORGE AVE.
CLEVELAND 5, OHIO

SCP SUPERIOR CARBON BRUSHES "Since 1919"

constructed of Type 416 stainless steel and measures approximately 1¼ in. dia, 1⅛ in. in length. Electrical connectioin is made through four numbered pin conectors. Pressure connections feature an ⅛ in. threaded inlet and a 5-40 female threaded inlet on the reference side. Weight is 60 g. Consolidated Engineering Corp., 300 N. Sierra Madre Villa, Pasadena 15, Calif.

For more information—
Circle 74, inside back cover

Miniaturized Electric Eyes

The size of photo-unit and light-unit is 1½x1 1/16x1 1/16 in. These units can be attached to ¾-in. pipe conduits to form fixed assemblies. Reflecting type units can be used to monitor, register, differentiate between surface qualities or to establish motion limits of paper or plastic sag. In certain cases reflection from a hot object or marked part can actuate controls.

A new probe model is readily inserted and positioned in production machines to monitor registration or other reflected edge of material. This unit, containing light source, phototube and lens, measures 4 in. long, 1 in. dia. Ess Instrument Co., 96 S. Washington Ave., Bergenfield, N. J.

For more information—
Circle 75, inside back cover

Dial Thermometers

Two color variations in the dial face are used. In one, the contrast is black on white with the degree graduations, numbers and indicator in jet black on a white background. In the other, the contrast is white on black with the graduations, numbers, and indicator tip in white on a jet black background. All dial faces are 4 in. dia.

The thermometer itself is bimetal-

from cereal guns to large caliber guns with

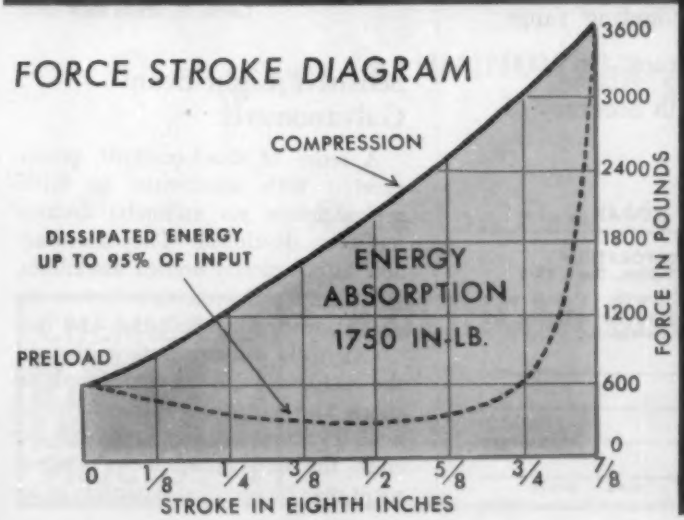
WALES Hydra Springs

NEW Wales Hydra Spring with built-in valve for dampened return provides impact cushion for breech door of cereal guns and is also used on large guns as recoil springs.

Low mass of moving piston provides the desired high frequency spring action for gun applications. In addition, Wales Hydra Springs outlast and outperform mechanical springs plus shock absorbers.

This small, self-contained, dual action Wales Hydra Spring with *LIQUID COMPRESSIBILITY* is only 4¾" long including 1" stroke by only 2¾" in diameter. The characteristics of compressible liquids called Wales Comproils produce the astounding results shown in "Force Stroke Diagram" at lower left. Wales Hydra Springs are built for any spring force and dampened return combination.

Write for Wales Hydra Spring data TODAY so that you will have all the facts at your finger tips. Better yet, send us an outline of your present spring problem for a "no cost" analysis.



Hydra Spring Division

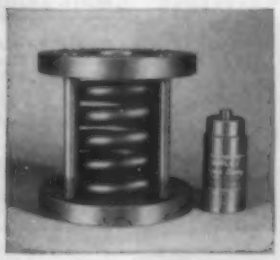
WALES-STRIPPIT CORPORATION

George F. Wales, Chairman

372 Payne Avenue, North Tonawanda, N. Y.

(Between Buffalo and Niagara Falls)

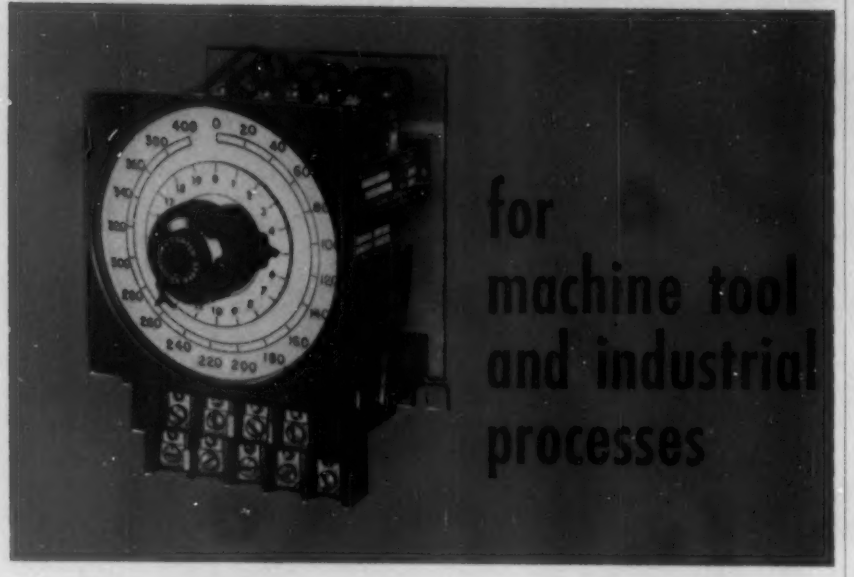
Wales-Strippit of Canada Ltd., Hamilton, Ontario



COMPARISON: The small, compact Wales Hydra Spring delivered as much force and stroke as the big caged railroad type coil spring.

Specialists in Machines and Compressible Materials

EAGLE
Microflex reset counter



makes shutdown and feed-down automatic

Convert machine tool and industrial processes from manual to automatic operation — with this Microflex Reset Counter. For example, use it to feed a grinding wheel down after a preset number of operations. Or employ it to shut down a machine at the desired number of operations. This reset counter is ideal for controlling chemical feeding processes by shutting down a pump after the desired number of operations.

The Microflex Reset Counter is actuated by a series of electrical impulses. Models are available with 400 and 1000 count dials. Dial settings easy to make — counting range from 1 to 400 in steps of 1 with 100% accuracy. On 1000 count range, dial settings are in steps of 1 with accuracy of ± 1 count. Spring reset in less than 1 count.

EAGLE TIMERS SAVE TIME . . . SAVE MONEY

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Industrial Timers Division
MOLINE, ILLINOIS

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MOLINE, ILLINOIS

Please send free Bulletin 720 containing full data on Microflex Reset Counter.

NAME AND TITLE

COMPANY

ADDRESS

CITY ZONE STATE

lic and accurate to percent of range at any point of indication. Stems are ¼ in. stainless steel, all-welded construction, and come in standard lengths of 4, 6, 9, 12, 18 and 24 in. for bottom or back connection. Separable sockets are available. The 5-in. dial case, made of pressure-cast aluminum alloy with black crackle finish, is moistureproof and has a strong fumeproof bezel. Precision Thermometer & Instrument Co., 1434 Brandywine St., Philadelphia 30, Pa.

For more information—
Circle 76, inside back cover

Panel Meters in 2½ and 3½ in. Sizes

These meters are reported to meet standard ASA and JAN dimensional requirements. Where panel space is at a premium, the longer dial arc, larger numerals and longer pointer allow a small meter of this type to replace a larger standard meter. The new meters are available in various colors. Marion Electrical Instruments Co., Manchester, N. H.

For more information—
Circle 77, inside back cover

Sensitive Light Beam Galvanometer

A series of shock-resistant galvanometers with sensitivities to 0.105 microamperes per milimeter division has been developed. They are available as completely housed assemblies, with lamp and projection system included, ready for installation and use.

Originally developed to withstand the extremely severe conditions of shock and vibration encountered in field servicing and testing of jet aircraft, the new galvanometer's movement may be installed separately as an

Alodizing with *Alodine*® No.1000
Provides
INVISIBLE PROTECTION for ALUMINUM

"Alodine" No. 1000 protects aluminum without changing its appearance. It is a natural for treating aluminum windows, doors, frames and, in fact, any aluminum product when it is desirable to retain the metal's original appearance even under severe service conditions.

"Alodine" 1000 can be applied by immersion, by spraying in a power washer, or even manually.

With "Alodine" 1000, a simple, economical, effective method is now available for providing invisible protection for aluminum and its alloys.

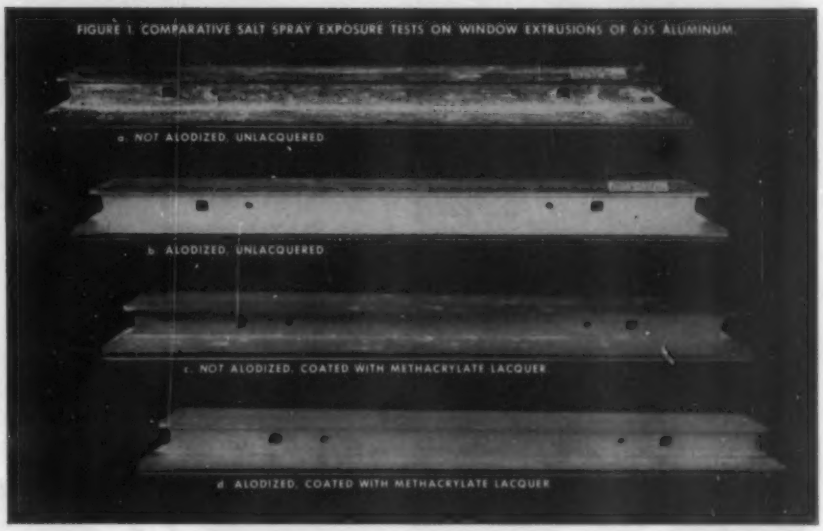


FIGURE 1. COMPARATIVE SALT SPRAY EXPOSURE TESTS ON WINDOW EXTRUSIONS OF 63S ALUMINUM.
a. NOT ALODIZED, UNLACQUERED
b. ALODIZED, UNLACQUERED
c. NOT ALODIZED, COATED WITH METHACRYLATE LACQUER
d. ALODIZED, COATED WITH METHACRYLATE LACQUER

How effectively Alodine No. 1000 protects aluminum extrusions (63S) in salt fog is shown above.

The surface of the bare extrusion (a) is darkened, has lost its new look, and is badly pitted, while the Alodized, unlacquered extrusion (b) has retained its original appearance without pitting or visible corrosion, after 864 hours' exposure to salt spray.

The bare metal extrusion (c) coated with lacquer shows some darkening from general corrosion and some pitting after 1200 hours' exposure to salt spray, though less than on the unlacquered extrusion (a). However, extrusion (d) both Alodized and lacquered is unchanged in appearance with no pitting.

While it is noteworthy that bare metal when merely Alodized has withstood salt spray at least as well as bare metal lacquered, lacquer applied to an Alodized surface provides the utmost in protection and abrasion resistance, and meets the requirements of the mortar test of FHA Circular No. 4.

IF IT'S ALUMINUM, BE SURE IT'S "ALODIZED"

Write for new descriptive folder.

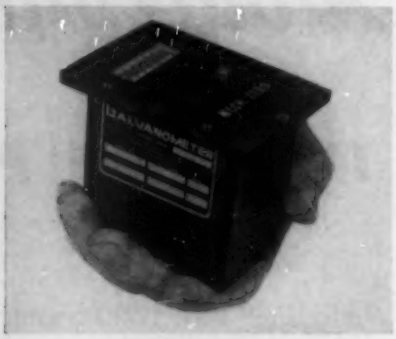
CHEMICALS
ACP
PROCESSES

AMERICAN CHEMICAL PAINT COMPANY

Ambler, Penna.

Detroit, Michigan *Niles, California* *Windsor, Ontario*

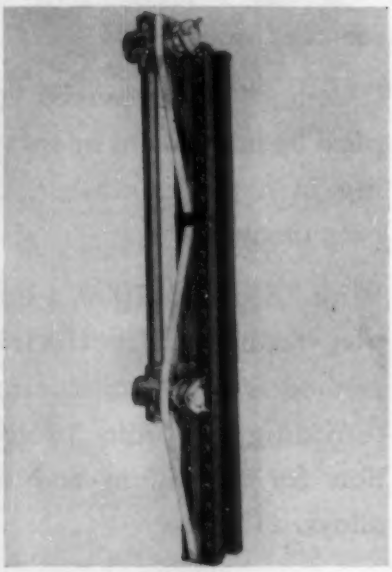
FOR YOUR
Special
HINGES
Consult STANLEY
A REPUTABLE SOURCE
A COMPLETE SERVICE
PRESSED METAL DIVISION
THE STANLEY WORKS, 686-P Lake St., New Britain, Conn.
OFFICES: NEW YORK, CHICAGO, SAN FRANCISCO, LOS ANGELES AND SEATTLE
SPECIAL HINGES, STAMPINGS AND DEEP DRAWINGS
STANLEY TOOLS • STANLEY HARDWARE
STANLEY ELECTRIC TOOLS • STANLEY STEEL STRAPPING • STANLEY STEEL



integral part of other industrial instrumentation in the fields of colorimetry and densitometry, or for measurement of electric potentials, conductivity, light flux or temperature.

Overall size is 2.6x3.62x3.615 in. Coil resistances: 20, 100, 500 and 1000 ohms. Howell Instrument Co., 1106 Norwood, Fort Worth, Texas.

For more information—
Circle 78, inside back cover

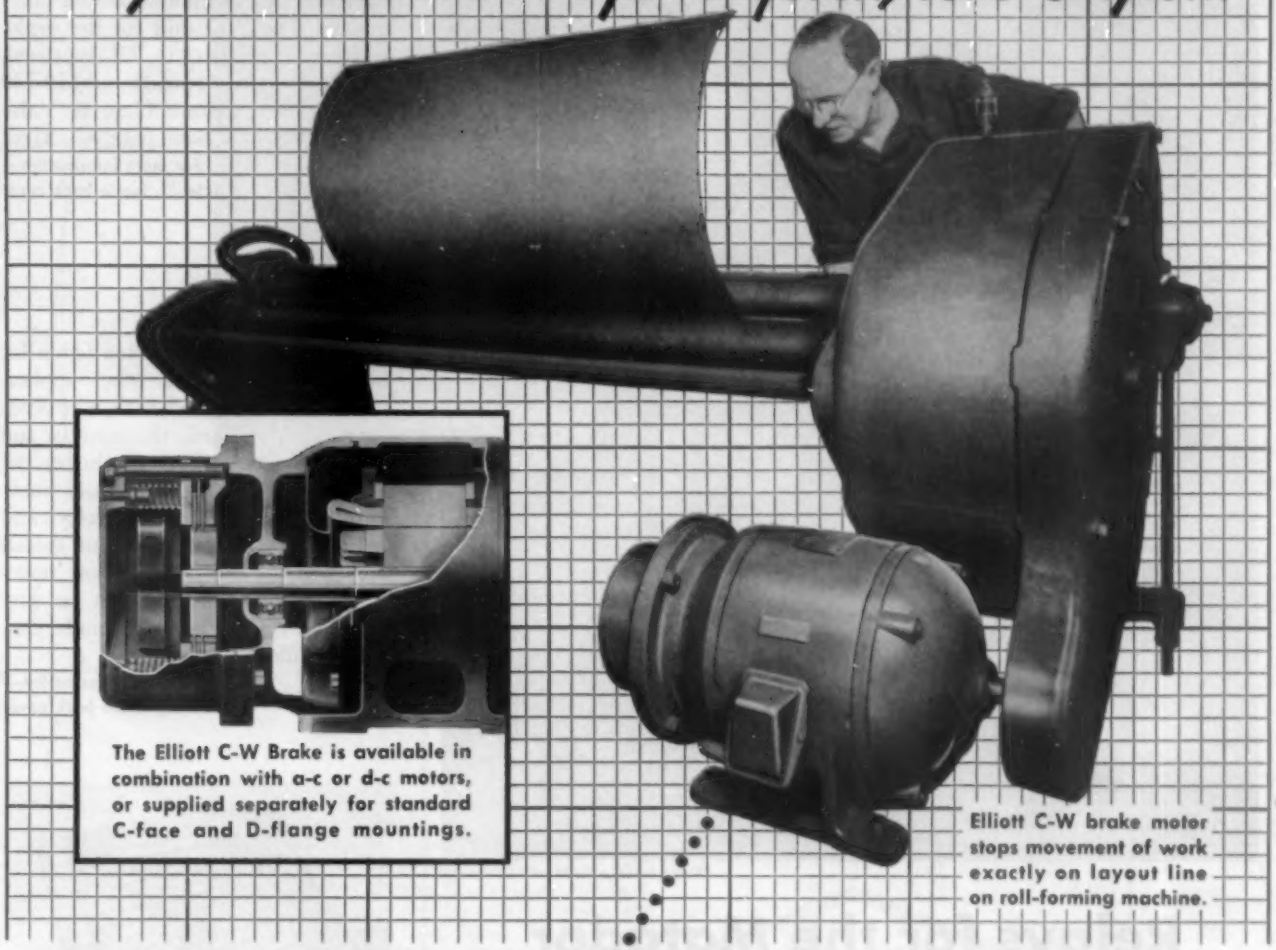


Gage Illuminator

A gage illuminator is now available that incorporates the principle of solid-wedge lighting combined with plastic. Illumination from a single source (a 15 or 60 w bulb) is reflected from the angular surface of a ¾-in. thick plastic wedge and flows with evenly diffused intensity through the transparent gage glass. The plastic wedge is mounted in an improved way, leaving a space between the wedge and the glass. This facilitates cleaning and leaves space which allows the illuminator to be used on higher temperature gages.

These illuminators are available in

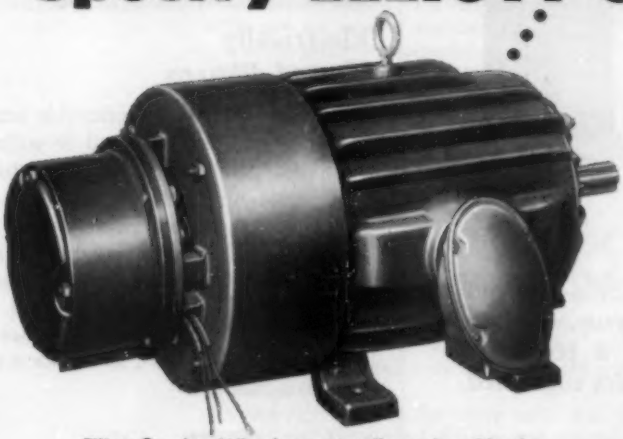
If your machines require quick, sure stops...



The Elliott C-W Brake is available in combination with a-c or d-c motors, or supplied separately for standard C-face and D-flange mountings.

Elliott C-W brake motor stops movement of work exactly on layout line on roll-forming machine.

Specify ELLIOTT C-W Brake Motors



Elliott Crocker-Wheeler a-c totally-enclosed brake-motor. A popular unit for applications near dirt, dust or fumes. Brake is totally-enclosed, too.

Assure improved performance to machine tools, textile machinery, material handling equipment, automatic welders and countless other machines with this easily applied, compact brake motor. It provides frequent and instantaneous starts and stops and can be utilized for holding service. Brake is disc type with rugged, long-wearing bonded metal lining.

Quick-removable wrap-around cover enables inspection of all brake parts from side. Torque adjustment from outside of case. Complete details in Bulletin PB-9300-1. Write Elliott Company, Crocker-Wheeler Division, Jeannette, Pa.

ELLIOTT Company

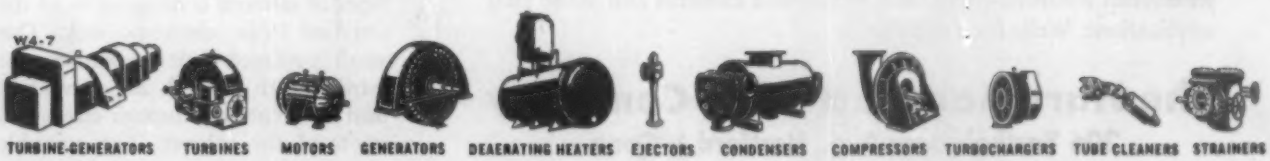


Photo courtesy the Martin Company

Relays for the Matador

by "DIAMOND H"

Matadors, surface-to-surface tactical missiles now deployed with USAF operational squadrons in Germany, are products of the Martin Company, Baltimore.

The relays, developed to help control its near speed-of-sound flight, are products of The Hart Manufacturing Company.

They're 4 PDT hermetically-sealed relays with a previously unobtainable combination of dependable characteristics engineered into remarkably small space and weight.

A new bulletin gives complete data on the wide range of performance characteristics which can be obtained with "Diamond H" Series R relays for critical jobs in the *Matador* and other missiles, jet aircraft controls, computers, high-speed cameras and other vital applications. Write for a copy today.

The Hart Manufacturing Company

206 Bartholomew Ave., Hartford 1, Conn.

explosion proof or non-explosion proof models. The light unit for the explosion-proof models is UL-approved. Standard models operate on 110-120 v, ac or dc. Jerguson Gage & Valve Co., 80 Fellsway Somerville 45, Mass.

For more information—
Circle 79, inside back cover

Miniature Indicator Lights

A line of neon indicator lights for home appliances and other applications can be supplied with wire leads or blade-type quick disconnects and built-in resistors. This eliminates the need for transformers or series hookups. A wide range of lens colors and configurations is available and special shapes in the form of company trademarks or other devices can be produced on volume orders. Ucinite Co., Newtonville 60, Mass.

For more information—
Circle 80, inside back cover

Electrically Heated Platens

These platens have replaceable heating units and are machined to within 0.005 in. parallel. Their temperature range goes up to 600 F max. They can withstand compression up to 7,000 psi. They are available in all sizes up to 8 by 12 ft. Thermal, Inc., 3440 W. Lake St., Chicago 24, Ill.

For more information—
Circle 81, inside back cover

Cabinet Cooling Fan

A rack-mounted, self-contained fan unit for cooling electronic and other types of cabinets is designed to fit the standard 19-in. electronic rack. This small packaged unit pressurizes the cabinet with filtered air, preventing dust from entering through cracks and joints of the cabinet. The assembly

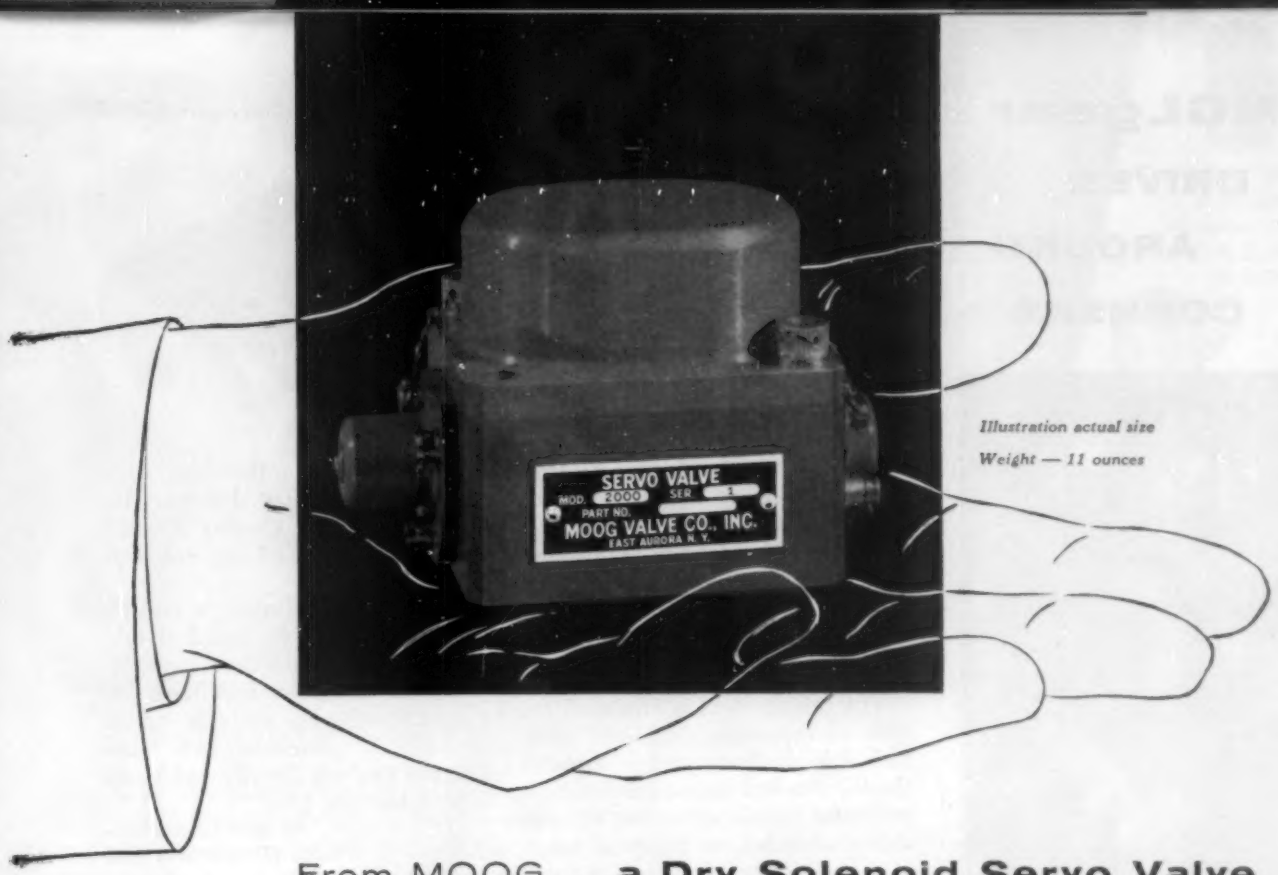


Illustration actual size

Weight — 11 ounces

From MOOG . . . **a Dry Solenoid Servo Valve**

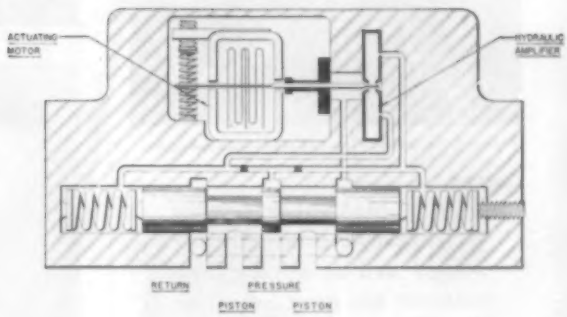
For those electro-hydraulic servo systems which require valves of high dynamic performance, reliability, small size and low weight, Moog units have achieved recognition as the industry standard.

And now, for those systems in which the fluid contains entrained iron, Moog has developed the Model 2000 Servo Valve. These units feature a dry solenoid which eliminates the possibility of torque motor contamination due to magnetic particles. These valves comply with requirements of MIL-H-5440A and are smaller and lighter than other Moog units of the same flow capacity.

Moog Valves, including Model 2000, are proportional type, electrically actuated, hydraulic, four-way valves featuring high dynamic response, sensitivity, linearity, and reliability. Production models are designed to operate in hydraulic systems of from 1000 to 3000 psi pressure. Rated output flows from 0.1 to 50.0 GPM for control currents of from 2.0 to 40.0 milliamperes as specified are available in production units.

Conventionally the valve input is from a balanced push-pull DC amplifier and the valve flow output is applied to a piston or hydraulic motor. An electric signal proportional to piston position or motor angular rotation is fed back to the amplifier to give a closed servo loop.

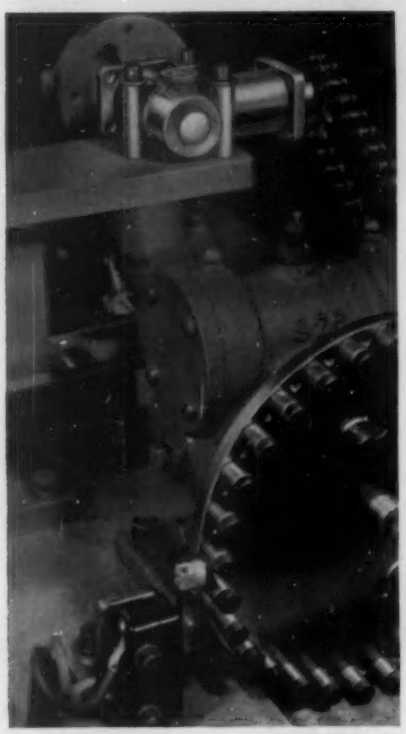
Typical applications for these units are in servo systems used for guided missile and aircraft flight controls, radar scanner actuation, contour following machine tools, and automatic packaging equipment.



For details write for Bulletin 2000-4

MOOG VALVE CO., INC. PRONER AIRPORT EAST AURORA, N. Y.

ANGLgear
DRIVES
AROUND
CORNERS



Photograph courtesy Wrap-Ade Machine Company, Inc.

This use of ANGLgear as the power take-off between a gear reducer and an agitator demonstrates the great advantage of a standardized bevel gear unit over a custom-made take-off. Engineers and designers, intrigued by ANGLgear's small size and compact design, continue to favor it over specially built units. ANGLgears are rated up to 2½ hp at 1800 rpm. All models are made with 1-1 gear ratio and with 2 or 3-way shaft extensions. Contact your local distributor, or write to us for information.

AIRBORNE
ACCESSORIES CORPORATION
HILLSIDE 5, N.J.

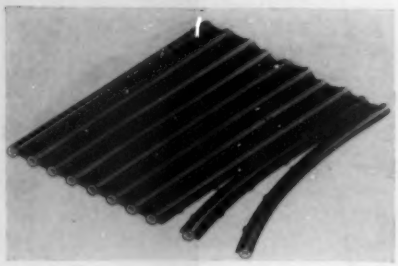
is rack-mounted the same as other chassis. It contains a hidden replaceable filter which is replaced from the front by merely removing the stainless steel grille. Assembly is complete in one unit, ready for use.

Air delivery is 300 cfm. Mounting panel is 7 x 19 in. wide. The motor is fan-cooled, rubber mounted, and has a speed of 1500 rpm. It is 58 w, shaded pole, with life-lubricated sleeve bearings. Power requirement is 115 v, 60 cps. McLean Engineering, Box 228, Princeton, N. J.

For more information — Circle 82, inside back cover

Copper and Aluminum Instrument Tubing

This tubing comes in a ribbon form, with 10 copper or aluminum tubes, each individually encased in a plastic sheath, attached to each other by a perforated plastic web. One or more individual tubes, or group of tubes,

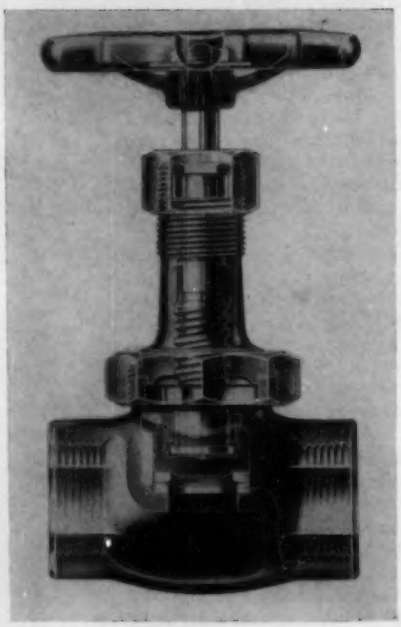


can be stripped from the ribbon without tools and without destroying the protective coating. Coating is 0.020-in.-thick elastomeric black polyvinyl-chloride.

This "ribbon" of tubing is available in lengths to 500 ft. Standard tube OD is ¼ in., with 0.030 in. copper or 0.032 in. aluminum wall tubes. he ⅜ in. OD tube has 0.032 in. copper or 0.035 in. aluminum wall tubes. Dekoron Products Div., Samuel Moore & Co., Mantua, Ohio.

For more information— Circle 83, inside back cover

FLUID POWER AND CONTROL



Valve with High Hardness Seat and Disc

The seat and disc of a bronze globe valve recently introduced is not just surface-hardened, but hard all the way through. It is said to possess more wear and corrosion resistance than stainless steel rated at 500 Bhn, and far more than case-hardened stainless exceeding 1000 Bhn.

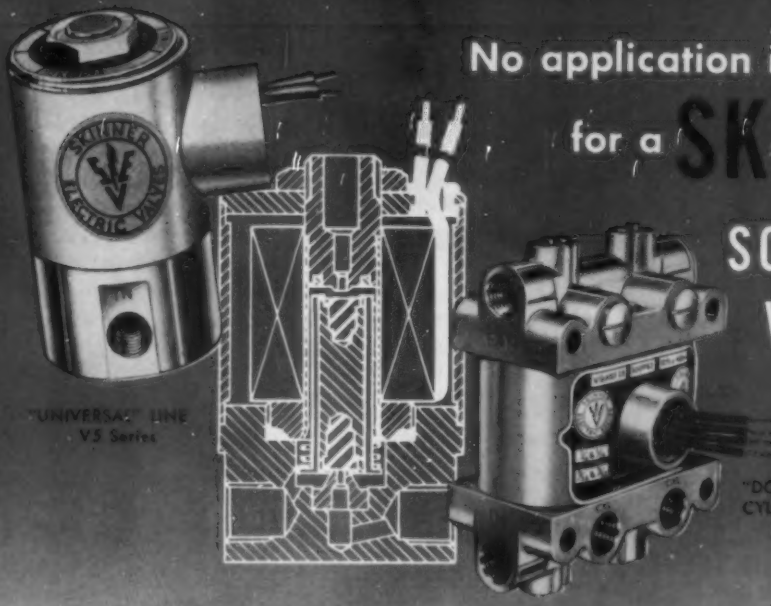
The flat-seat design of the valve is also new. Engineers have long considered flat-seat designs impractical for throttling service, because ordinary seating materials failed rapidly by wire-drawing. The new alloy can be fused permanently. The seats and discs in the LQ600 valve are not expected to require replacement, renewing or regrinding. Lunkenheimer Co., Box 360, Cincinnati 14, Ohio.

For more information— Circle 84, inside back cover

Vent and Breather Valve

A pop-off relief valve seals tight with no leakage below release pressure and reseats dead tight within 10 per cent of this value. Sealing is provided by a resilient member fitted into the poppet head which seats into a spherical section in the valve body. When in the closed position the metal-to- metal seating limits the compressive load on the resilient seal and contains it to withstand the pressure load. The spherical valve seat elimi-

No application is too tough for a SKINNER SOLENOID VALVE!



These compact, rugged valves perform millions of cycles ...in countless applications

The V5 and the V9 are typical of the high-quality, small size valves which Skinner offers for general service applications. Both give fast, dependable operation and positive performance. Both are direct-acting, spring loaded, *leakproof*. And both of them are sturdily constructed . . . to give maximum service through long, severe use.

V5 - "Universal" Line

UL-approved — suitable for all common media on pressure or vacuum. Available in a broad selection of types, electrical outlets, port locations and sizes, flow adjustments and coil types. Also available with UL-approved Explosion-Proof construction and with "Quick Exhaust" for extra-fast cylinder return. *Simple to inspect* — can be disassembled without removal from the line.

Specifications: Type — 2- or 3-way, normally open or normally closed, or directional control. Pressure rating — 0-1000 p.s.i. Vacuum to 5 microns.

V9 - "All Purpose" Four-Way

For precision control of double-acting cylinders or two single-acting cylinders . . . at speeds up to 600 cycles per minute! Available with 176 variations of types, capacities and adjustable flow arrangements. Can be used with air, hydraulic, oils and other common media. Die-cast zinc bodies.

Specifications: Type — normally open, normally closed, or combination — normally open and normally closed. Pressure rating — 0-150 p.s.i. Vacuum to 5 microns.

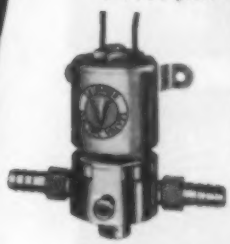
Do you have a solenoid valve problem? Call in a specially trained Skinner resident engineer— he'll tackle your problem immediately.

GENERAL SERVICE & VACUUM
V5 Series
2- & 3-Way
0-1000 p.s.i.

MINIATURE CUT-OFF
V2 Series
2-Way
0-250 p.s.i.

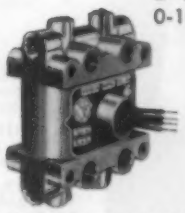
QUICK EXHAUST
(extra fast cylinder return)
QV5-3 Series
3-Way
0-150 p.s.i.

HI-PRESSURE HYDRAULIC
V10 Series
2- & 3-Way
0-1000 p.s.i.

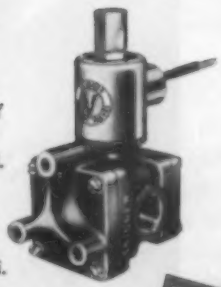


SANITARY
V4 Series
2-Way
0-20 p.s.i.

EXPLOSION-PROOF
X5 Series
2- & 3-Way
0-1000 p.s.i.



ALL-PURPOSE FOUR-WAY
V9 Series
4-Way 0-150 p.s.i.



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2- & 3-Way 5-150 p.s.i.

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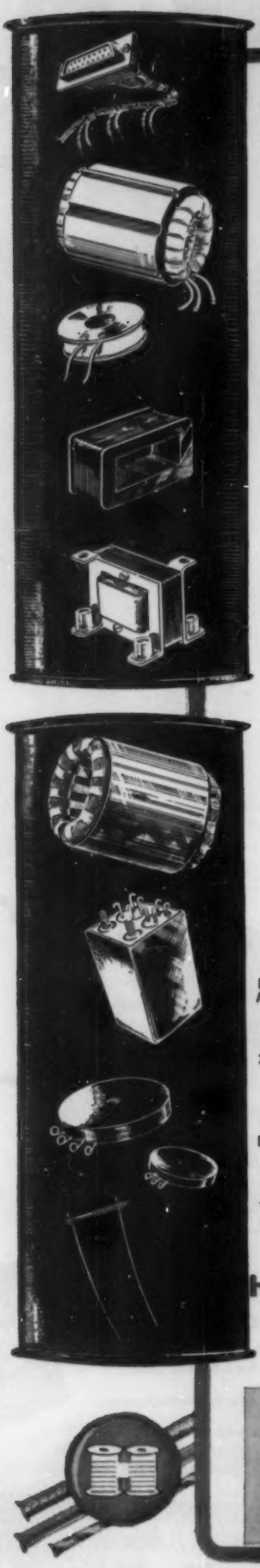

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ST. LOUIS, MO. White Supply Co. 4343-47 Duncan Ave.	**HIGHLAND PARK, MICH.** James B. Morrow 85 Louise Avenue	**MIAMI, FLA.** Larry Johnson 117 NW 103rd St.

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- "TEMPRENE", TEFLON HOOK-UP WIRE
- "TEMPREX", TEFLON EXTRUDED HOOK-UP WIRE
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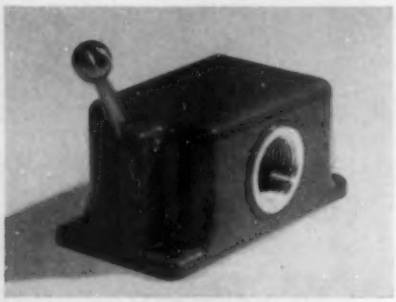
- "RETEP", TEFLON SATURATED GLASS BRAID LEAD WIRE
- "NEBROC", TEFLON GLASS FIBRE CORD, TAPE AND THREAD
- "TEMPTUBE", TEFLON GLASS FIBRE SLEEVING
- "THERMALON", SILICONE MAGNET WIRE

nates the need for close stem alignment and troublesome close sliding fits in the sealing area. Adjustment is internal, protected and cannot be tampered with.

This valve is recommended for applications where pressures are from 1 to 125 psi and maximum flow and minimum pressure drop are required. James-Pond-Clark, 2181 East Foothill Blvd., Pasadena 8, Calif.

For more information—
Circle 85, inside back cover



Vacuum-Sealed Valve

This valve contains no sliding or rotating seals, and so will not develop leakage after continued use since the seals are not subject to wear.

The valve contains no springs, the seal being maintained by the vacuum in both positions. A higher vacuum increases the effectiveness of the seal. The valve seats themselves are self-cleaning and are said to require little attention. This valve is available in various sizes and porting arrangements, making it adaptable to many applications. Brent & Davis Machine Co., 7213 Santa Monica Blvd., Los Angeles 46, Calif.

For more information—
Circle 86, inside back cover

Alloy Gate, Globe, Angle Valves

This line of valves provides a split-wedge disc design in the gate valves and an improved disc-stem connection in the globe and angle valves. Materials in which they are regularly available are 18-8 stainless and high-nickel, high-chromium stainless. Teflon packing is used in all the valves.

The split-wedge disc in the gate valves is made up of two identical, circular discs placed back-to-back in a carrier. The discs have a convex trun-

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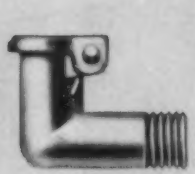
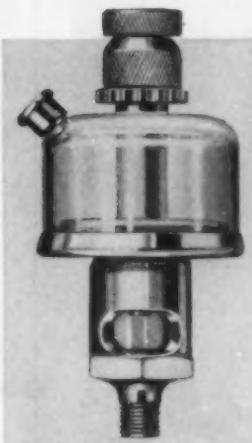
OIL HOLE COVERS

This model is designed to fit into a simple drilled hole. Ideal for use on small motors, generators, starters and light machinery—for dependable oil hole protection at moderate cost. Larger sizes frequently used as filler caps on tanks or reservoirs. Style R—No. 305.



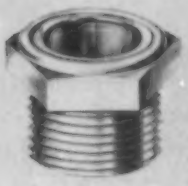
OIL CUPS

Accurately machined from a solid brass one-piece forging, this oil cup permits safe, dependable application of lubricant at very low cost. Used widely on motors and small machinery requiring side oiling. Style L—No. 1202.



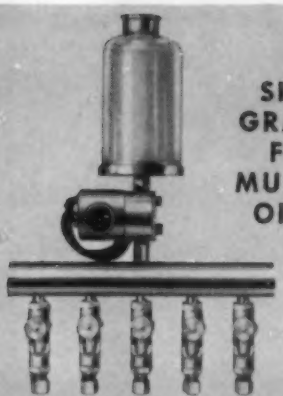
SIGHT GRAVITY FEED OILERS

Rate of oil flow regulated by needle valve, directly observed through sight glass in stem. Shut-off knob does not affect needle valve adjustment. Visible oil supply. Non-breakable. Tops in convenience and dependability, at low cost. Style NFU—No. 3602-A.



GEAR CASE GAUGES

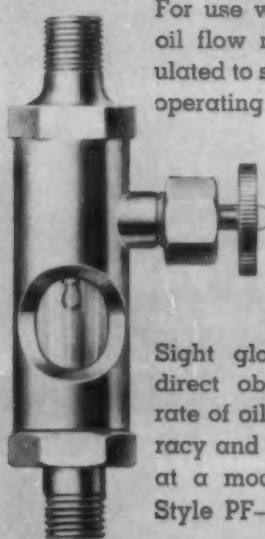
This oil gauge plug permits instant checking of oil level within a transmission or gear case. For use where construction permits insertion in tapped hole. A valuable addition to any such equipment — at very low cost. Style BW—No. 4042.



SIGHT GRAVITY FEED MULTIPLE OILERS

This one unit replaces 3 to 8 individual oilers. Maximum practicality in a small central lubrication system. Positive cut-off during idle periods. Individual vibration-proof needle valve adjustments. With solenoid control (Illustrated): Style MDS—No. 4685-A. Without solenoid: Style MD.

SIGHT GAUGES



For use where rate of oil flow must be regulated to suit changing operating conditions. Needle valve permits extremely accurate adjustment of oil feed. Sight glass provides direct observation of rate of oil flow. Accuracy and convenience at a moderate price. Style PF—No. 4290.

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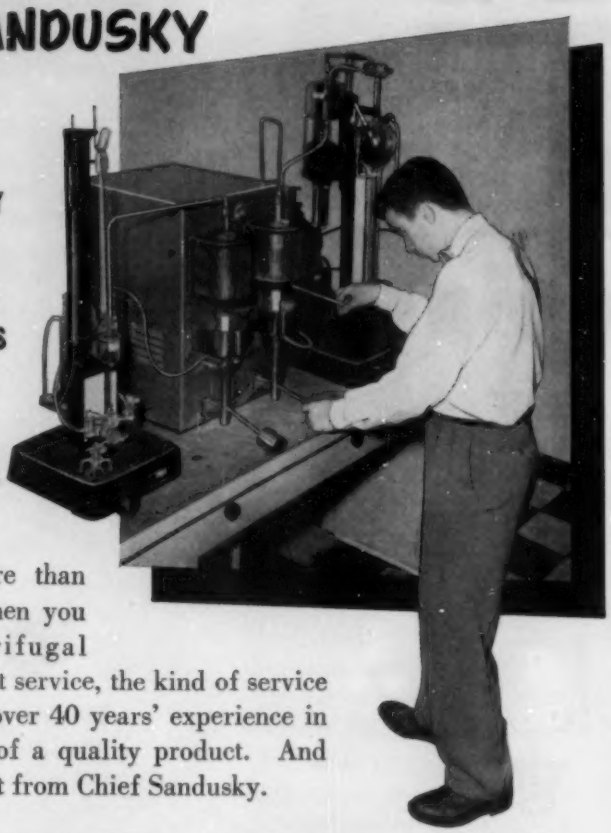

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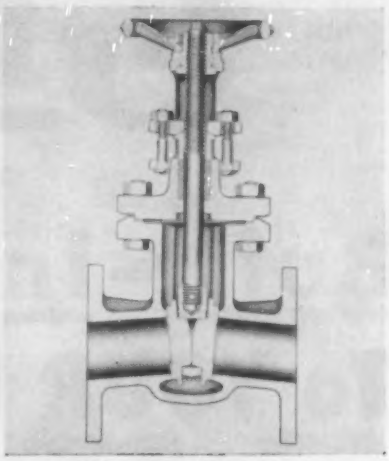


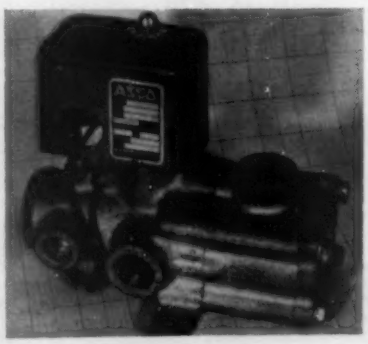
nion on the back and an integral circumferential flange which bears on guide slots in the valve body. The new valves have screwed ends, in the ½ to 2-in. sizes, inclusive, and flanged ends in ½ to 6-in. sizes, inclusive. Crane Co., 836 S. Michigan Ave., Chicago 5, Ill.

For more information—Circle 87, inside back cover

Gate Valve for Soldered Tube Installations

A brass sweat-type valve is for working pressures of 125 lb steam. Sizes available include ⅜, ½, ¾, 1, 1¼, 1½ and 2 in. Milwaukee Valve Co., 2375 S. Burrell St., Milwaukee 7, Wisc.

For more information—Circle 88, inside back cover



Four-Way Solenoid Poppet Valve

This solenoid valve was designed to eliminate piston malfunction due to binding or residual magnetism. It is said to provide cycling rates up to 850 per min. Power operated in both directions, spring action has been

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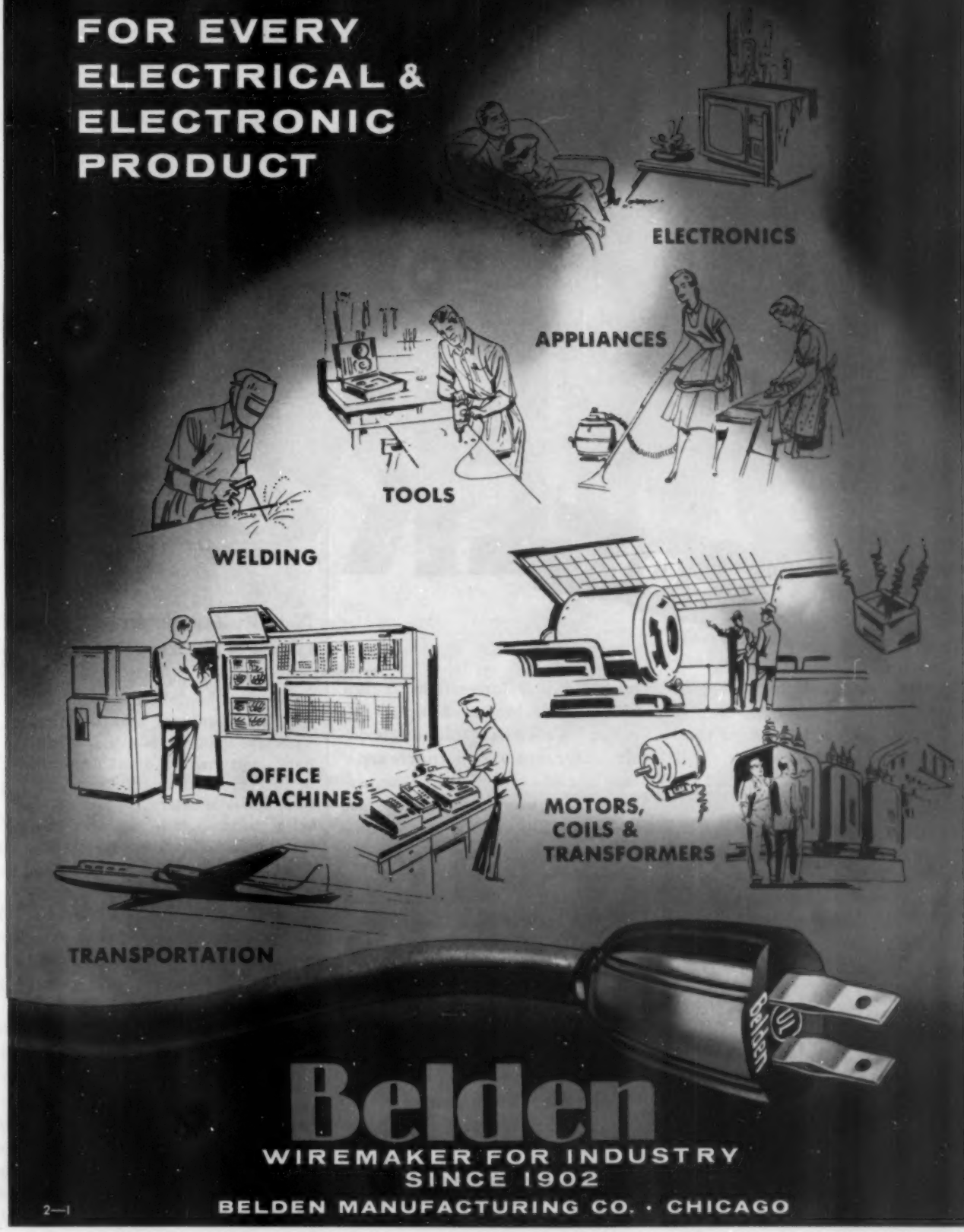

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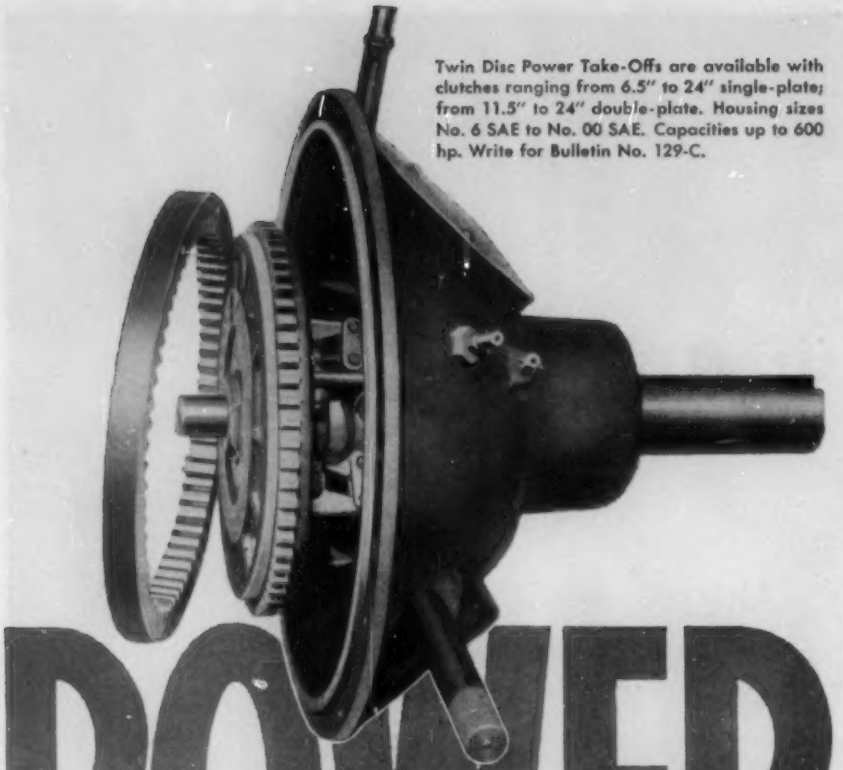

Twin Disc Power Take-Offs are available with clutches ranging from 6.5" to 24" single-plate; from 11.5" to 24" double-plate. Housing sizes No. 6 SAE to No. 00 SAE. Capacities up to 600 hp. Write for Bulletin No. 129-C.

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Next time you're watching powered equipment driving through a friction power take-off, check the name plate on the drive back of the engine. In all probability, you'll see a Twin Disc Power Take-Off, putting *more horsepower to work.* With their simple, *rugged* design—single-point adjustment—and slippage capacity far in *excess* of horsepower rating, *Twin Disc Power Take-Offs are selected as standard equipment by most of the nation's leading industrial engine manufacturers.*

That's why you'll find Twin Disc Power Take-Offs on such leading industrial engines as Ajax - Buda - Caterpillar - Climax - Continental - Cummins - Hercules - International - LeRoi - Minneapolis-Moline - Murphy - Superior - Waukesha - White - Wisconsin . . . for these manufacturers know they can depend on Twin Disc performance . . . and they know, too, that wherever their engines may be ultimately working, Twin Disc Service will only be a matter of hours . . . backed by 60 Parts Stations and 8 Factory Branches or Sales Eng. Offices.

TWIN DISC

TWIN DISC

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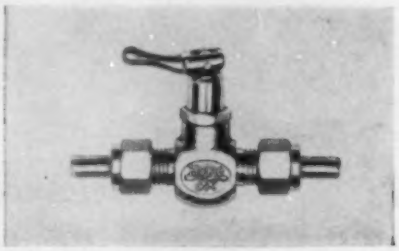
eliminated entirely. Total moving parts have been cut to three in number. The valve is available as either a single or dual solenoid, depending upon the electrical circuit involved. The dual solenoid valve has the additional safety advantage of locking into position on power failure.

The new valve is designed to operate in any position and on all standard voltages. Power consumption is only 10 w. Standard, watertight or explosion-proof models can be supplied. The dual solenoid valve is built to withstand pressures up to 500 psi, the single solenoid to 250 psi. The $\frac{3}{8}$ in. pipe size is in production; $\frac{1}{4}$, $\frac{1}{2}$ and 1 in. sizes will be available shortly. Automatic Switch Co., 391 Lakeside Ave., Orange, N. J.

For more information—
Circle 89, inside back cover



Needle, Toggle and Check Valves

A line of needle, toggle and check valves has been introduced having tube end hardware that does away with pipe-to-tubing adapters or flaring tools. They permit direct connection of the tube end to the valve with a turn and a quarter of a wrench, resulting in what is described as a torque-free, leak-proof seal. Hoke, Inc., 197 S. Dean St., Englewood, N. J.

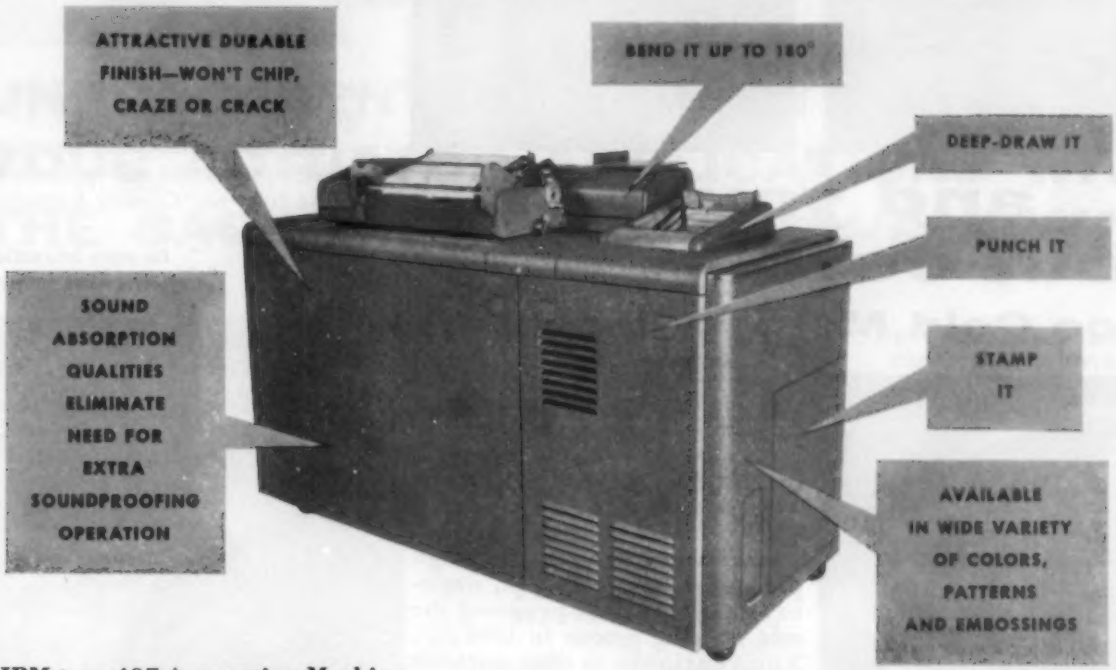
For more information—
Circle 90, inside back cover

Three and Four-Way Valves

Cross-sectional areas of oil passages in this line of valves is said to be equal to or greater than the cross-sectional area of the $\frac{3}{4}$ in. ID pipe for which they are designed.

In operation with hydraulic motors, an unusual "feathering" characteristic is accomplished. This means that smooth operation of the hydraulic motor is provided at extremely low to

Sullvyne-Clad Metal Laminate Chosen by IBM for Improved Appearance and Virtually Indestructible Finish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Actual photograph of Sullvyne-Clad sheets in Blonde Mahogany and Buffalo Grain, Coffee Brown.

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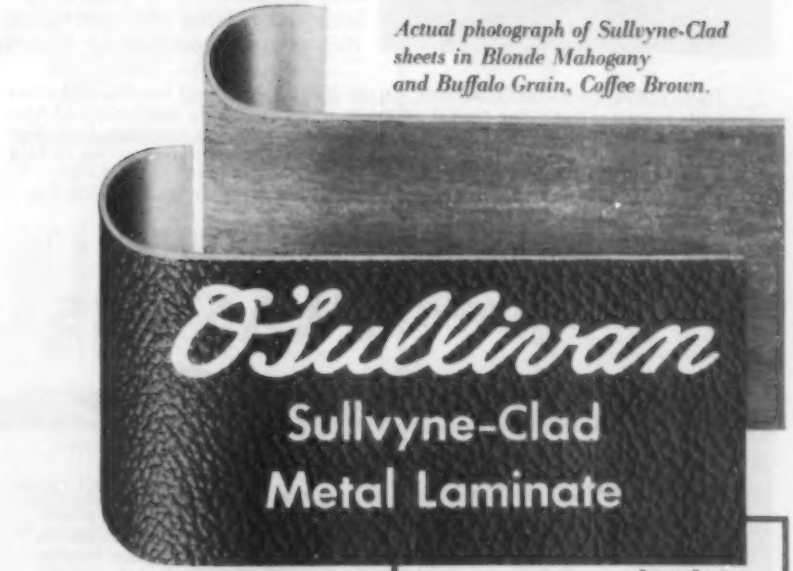
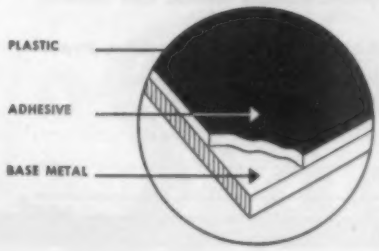
No special dies or drawing compounds are necessary. Bond strength will vary according to the metal used and the thickness of the vinyl—the average is 35 lbs. per inch.

Sullvyne-Clad slashes service costs; gives you a finish many times thicker than any conventional coating—.012" to .030". It has positive resistance to abrasion and corrosion; won't chip, crack or craze; far superior to ordinary paint, lacquer or enamel.





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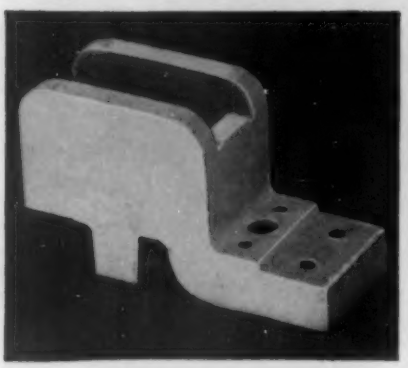
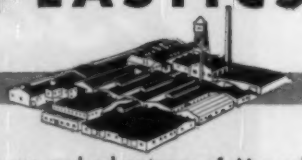
...and you can cut costs with Aico Cold Molded Plastics



When your products call for parts with high arc resistance and proven stability at operating temperatures up to 1000° F . . . that's when Aico's cost-cutting cold molding process offers a money-saving opportunity. Cold Molding . . . the original plastics molding method offers high production from a low-cost, single-cavity mold. Aico pioneered the cold molding process in 1916 . . . Aico continues to offer manufacturers the latest improvements in this proven, cost-cutting process.

These control knobs, valve handles, pigtail connectors, utensil handles and other parts represent but a few typical examples of the profitable application of Aico Cold Molded Plastics. Many such cold molded plastics are available from Aico Stock molds to further reduce costs. Aico engineers are at your service to help with your specific production problems.

AICO PRECISION MOLDED **PLASTICS**



FREE Aico Booklet explains the use and advantages of Aico cold molded plastics. Also explains other phases of Aico's complete plastic molding service including: Engineering Counsel; Mold Building; Injection, Compression and the molding of Reinforced Plastics. Free Aico Plastics Applicator will determine the best plastic molding method and material for your product.

AMERICAN INSULATOR CORPORATION • New Freedom, Penna.

☐ Please send me free booklet on Aico's complete services.
☐ Please send my Free Plastics Applicator.

Name _____ Position _____

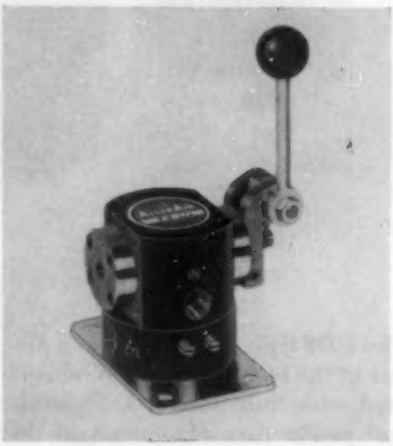
Company _____

Address _____

infinite speed ranges, within the engineering limits of the motor.

The valve is smooth in action from "hold" position to full application of oil at 2000 psi. Century Engineering Co., Waukesha, Wis.

For more information—
Circle 91, inside back cover



Four-Way Air Control Valves

Twenty-four different models are available with ¼, ⅜ or ½ in. ports for operation from 5 to 150 psi. The key models are the double-solenoid, air bleed, air pilot and hand valve types.

The double solenoid valves, available for either 8 or 110 v, as well as the air bleed models, are of the momentary contact type. The hand and air pilot valves are offered either for double actuation or spring return. A. K. Allen Co., 57 Meserole Ave., Brooklyn 22, N. Y.

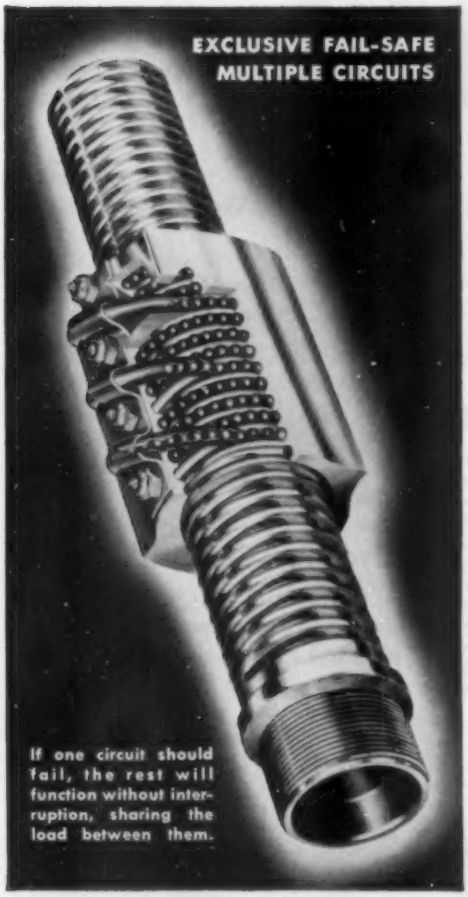
For more information—
Circle 92, inside back cover

Forged Steel Gate Valve

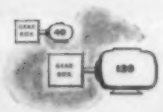
Gasket compression in this valve is said to be accurately controlled by holding close tolerances on both the body recess and the bonnet's raised

Now—

UNPRECEDENTED BENEFITS FOR ALL YOUR ACTUATOR APPLICATIONS WITH THE SAGINAW BALL/BEARING SCREW


EXCLUSIVE FAIL-SAFE MULTIPLE CIRCUITS
If one circuit should fail, the rest will function without interruption, sharing the load between them.

SPACE/WEIGHT SAVINGS PERMIT MORE PAYLOAD



Compared to either Acme screw or hydraulic actuators, the *Safety b/b Screw* saves significant weight and space by permitting the use of smaller motors and gear boxes; eliminating pumps, accumulators, piping, etc.

DEPENDABLE OPERATION DESPITE LACK OF LUBE

Because the *Safety b/b Screw* is inherently so friction-free (operating at 90% to 95% efficiency), it will function with only a small loss of efficiency *even if lubrication fails or cannot originally be provided.*

FAR LESS DRAIN ON ELECTRICAL SYSTEM

By requiring only 1/3 as much torque as a conventional Acme screw for the same amount of lineal output, the *Safety b/b Screw* allows the use of much smaller motors which save a substantial amount of power.

POSITIVE POSITIONING AND SYNCHRONIZATION

Unlike some other types of actuators, the *Safety b/b Screw* permits precision control within thousandths of an inch, plus perfect synchronization of two or more movements—a tremendous aircraft advantage.

RELIABLE PERFORMANCE AT EXTREME TEMPERATURES

Exhaustive laboratory tests prove that the *Safety b/b Screw* operates dependably at both extremely low and high temperatures, ranging from—75° F to + 175° F, and up to + 900° F with special consideration.

GREATLY DECREASED COMBAT VULNERABILITY

By eliminating highly vulnerable hydraulic lines, accumulators, etc., the *Safety b/b Screw* makes military aircraft actuation far more dependable. It also reduces maintenance, due to decreased dirt sensitivity.

UNITS HAVE BEEN PRODUCED FROM 1½ IN. TO 39½ FT.

SEND TODAY FOR YOUR FREE ENGINEERING DATA BOOK

(or see our section in Sweet's Product Design File).

Saginaw Steering Gear Div.,
General Motors Corp.
Dept. 61, Saginaw, Michigan

Please send your Engineering Data Book to:

Name—Title_____

Firm_____

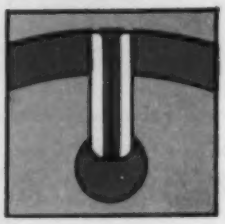
Address_____

City_____ Zone____ State_____

Safety ball/bearing *Screw* by *Saginaw*

CONTROLLED FLUID POWER TO SPEED UP TRAVERSE AND FEED CYCLE!

DUDCO PF-100 Series Double Pumps with combination relief and unloading valves provide high circuit flexibility through either automatic or external pilot control. For example...in a "hi-lo" circuit, large volume delivery is available for a fast traverse cycle. Then, during the feed cycle, when small volume is required, one pump section unloads automatically...saving dollars in horsepower! These pumps can also be operated on separate circuits . . . each circuit protected by its own relief valve.



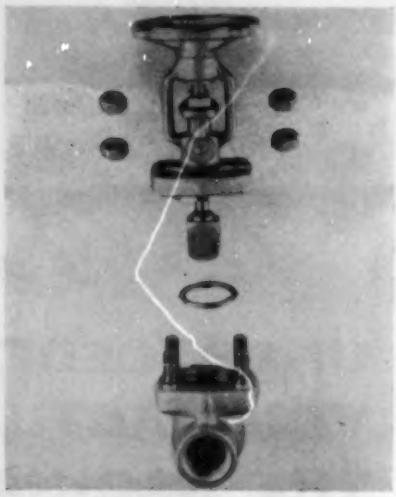
TWO VANES ARE BETTER THAN ONE

The hydraulically counterbalanced DUAL-VANES in DUDCO Hydraulic Pumps eliminate wear producing loads normally caused by unbalanced hydraulic forces and vane acceleration. DUAL-VANES also maintain MULTIPLE SEALING BARRIERS to slippage and power loss. DUAL-VANES are a patented and exclusive DUDCO feature.

DUDCO Pumps can operate *continuously* at 2000 psi. Their exclusive "Dual-Vane" feature and advanced design combine to assure long, trouble-free performance and maximum simplicity in servicing. Thus, they are a natural choice for a wide variety of high production equipment, including: Machine Tools, Hydraulic Presses, Die Casting and Plastic Moulding Machines, Closing and Clamping Devices and other functions calling for controlled variation in Pump volume.

The PLUS factors in DUDCO Pumps weigh heavily at the sales end—so, WRITE...get the facts on DUDCO Dual-Vane Hydraulic Pumps and Fluid Motors.

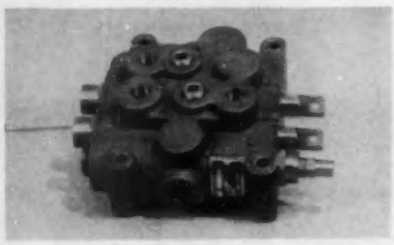
DUDCO DIVISION
THE NEW YORK AIR BRAKE COMPANY
1712 EAST NINE MILE ROAD • HAZEL PARK • MICH.
INTERNATIONAL SALES OFFICE, 90 WEST ST., NEW YORK 6, N. Y.



face. It is impossible to exert too much pressure on the gasket itself.

The valves have forged steel handwheels, stainless eye bolts and nuts, two-piece flange and follower and chrome-plated gates. Worcester Forged Steel Valve Co., 16 Parker St., Worcester, Mass.

For more information—
Circle 93, inside back cover



Hydraulic Control Valve

This control valve is for single and double-acting plungers. It is available for applications up to 60 gpm and pressures up to 2000 psi. There is an individual check valve for each operating plunger and adjustable relief valves, with or without float position, and alternate high pressure carryover. Hydraulic Unit Specialties Co., Waukesha, Wis.

For more information—
Circle 94, inside back cover

Will Hold In Either Position

This valve will hold in either operating position until the built-in relief valve unloads or until it is manually nudged from its operating position. The hardened spool is spring-

loaded to return to neutral where the load is held. Loads requiring from 500 psi to 2000 psi can be sensitively handled by any oil flow rate from 2 gpm to above 12 gpm.

The new valve is built to withstand surge pressures to 5000 psi. Three-point mounting and 360 deg swivel handle allow the valve to be placed in that position most convenient for the operator. All parts and mechanisms are completely enclosed. Char-Lynn Co., 2843-26 Ave. S., Minneapolis 6, Minn.

For more information—
Circle 95, inside back cover

Constant Speed Aircraft Hydraulic Motor

A line of oil hydraulic motors for constant speed applications in aircraft hydraulic systems is maintained within ±3 per cent of a pre-determined setting by a simple regulator which is built into the motor valve plate. These motors are presently available in sizes rated (at nominal rpm) from 2.3 to 18 hp. Vickers Inc., 1400 Oakman Blvd., Detroit 32, Mich.

For more information—
Circle 96, inside back cover

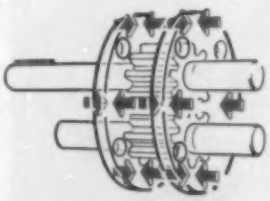
Dry Solenoid Valve

These servo valves are of the proportional type, electrically actuated, hydraulic, four-way. The torque motor is isolated from the hydraulic fluid.

HYDRECO
Oil Power

The famous HYDRECO Four-Bolt design Hydraulic Pump provides Oil Power on the John Deere No. 55 Self-Propelled Combine to position the Auger Platform and control the Variable Speed Drive. This model 1506 Pump delivers 3.3 gpm at 1200 rpm with pressures to 1500 psi... other models to 130 gpm.

Build the hydraulic circuit around the dependability of HYDRECO components. More and more design engineers find this premise leads to successful performance in service whether the application be farm equipment, machine tools, materials handling or construction machinery.



***Pressure Balanced* wear plates maintain a fixed clearance between wear plates and gear faces regardless of pressure. This feature in HYDRECO Pumps and Motors minimizes oil slippage and power loss... volumetric efficiency and mechanical efficiency remain high!**

HYDRECO Oil Power . . . Pumps, Motors, Valves and Cylinders have one important characteristic in common . . . they're *dependable*. And the engineering that contributes this dependability may be relied upon to make significant contributions to your present and projected hydraulic problems.

Write for brochures on HYDRECO Pumps, Motors, Valves and Cylinders.

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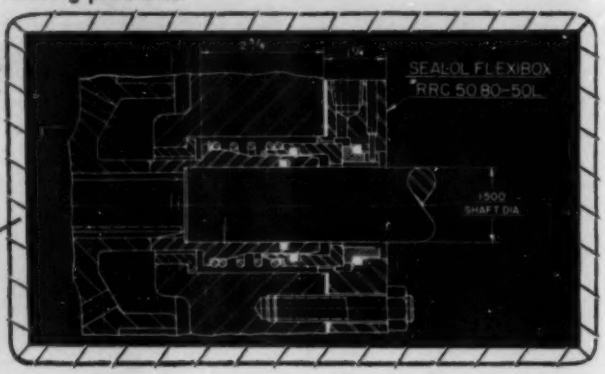
INTERNATIONAL SALES OFFICE, 90 WEST ST., NEW YORK 6, N. Y.

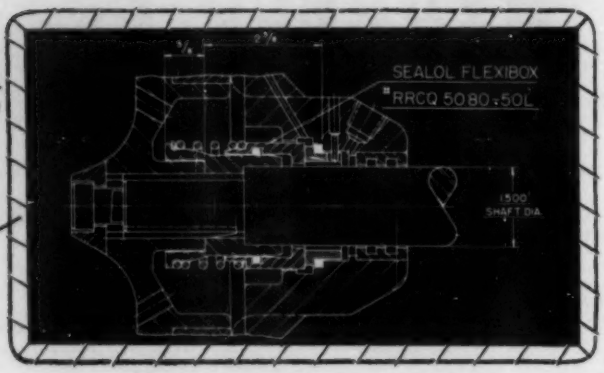
3 seals answer a thousand problems

Sealol-Flexibox — the high-efficiency mechanical seal with the unique spring drive — answers all types of shaft sealing problems.

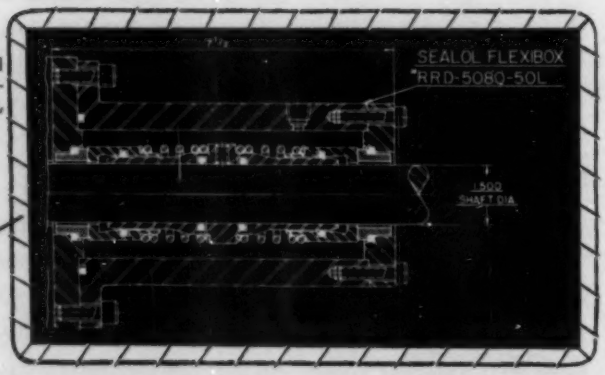
FOR STUFFING BOX INSTALLATION
Replaces conventional packing . . . positive sealing . . . long service life.



FOR DESIGNED-IN-PUMP INSTALLATION
Completely eliminates stuffing boxes — decreases shaft overhang.



FOR SPECIAL APPLICATIONS
Double seals; lubricated seals; special materials; designs for agitators, mixers, and special services.



Send for Bulletin 10, or tell us about your shaft sealing problems.

SEALOL CORPORATION, 177 POST ROAD, PROVIDENCE 5, R. I.

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SEALOL

THE BALANCED PRESSURE SEAL

These units are designed to operate in hydraulic systems of 1000 to 3000 psi pressure. Units having maximum output flows from 0.1 to 50.0 gpm for rated control currents between 2.0 and 40.0 milliampere are available. Weight is 11 oz and overall length is 3.06 in. Moog Valve Co., Inc., E. Aurora, N. Y.

For more information— Circle 97, inside back cover

All-Metal Motor Valve

A bellows-equipped all-metal motor valve has been developed for use with hydraulic and pneumatic control systems. Equipped with a cadmium-plated steel spring and two-ply seamless metal bellows, the valve can be used to maintain pressure, temperature or level in industrial vats, tanks and processes.

The series 992-D possesses a linear valve movement and is available in sizes from ¼ to 4 in. and in a wide variety of types. It is supplied in either direct or reverse acting styles. Robertshaw-Fulton Controls Co., Box 400, Knoxville, Tenn.

For more information— Circle 98, inside back cover

Hydraulic Steering Booster For Smaller Vehicles

This oil-hydraulic power steering booster is designed specifically for vehicles in the 4000 to 10,000 lb axle loading class. Assembly tie rods are eliminated and replaced with end caps which are screwed on and secured with removable tack-welded clips. The annular space between the double cylinder walls is utilized for booster oil flow, avoiding the need for external

When

SERVICE IS IMPORTANT

Rely on Bishop Stainless Steel Tubing for Faster Delivery...

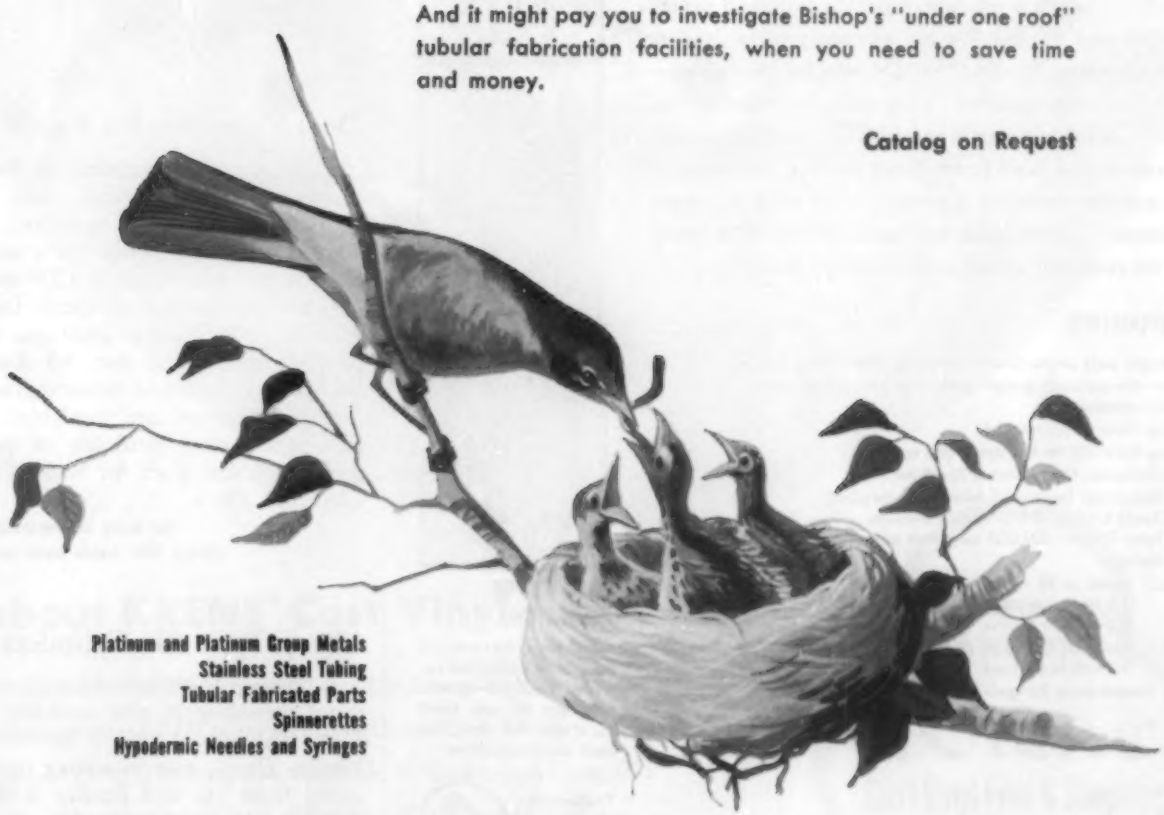
The first American Company to successfully draw small diameter stainless steel tubing, Bishop today specializes in faster delivery of your order. Prompt quotations, personalized service and efficient operation at the mill all contribute to answer your requirements.

Assistance from Bishop's experienced Engineering Department can also help to solve your present day tubing and design problems.

The next time service is important to you, rely on Bishop's 25 years in drawing stainless steel tubing (.008" to 1" O.D.) . . . and 113 years' experience in precision fabrication and quality craftsmanship.

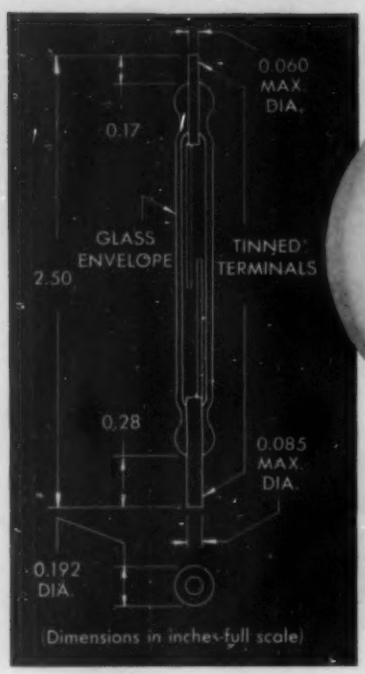
And it might pay you to investigate Bishop's "under one roof" tubular fabrication facilities, when you need to save time and money.

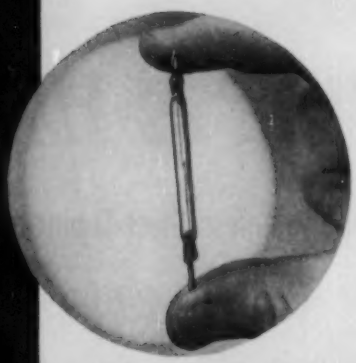
Catalog on Request



Platinum and Platinum Group Metals
Stainless Steel Tubing
Tubular Fabricated Parts
Spinnerettes
Hypodermic Needles and Syringes

J. BISHOP & CO. • PLATINUM WORKS • STAINLESS STEEL PRODUCTS DIVISION, MALVERN, PA.





the mighty little glaswitch*

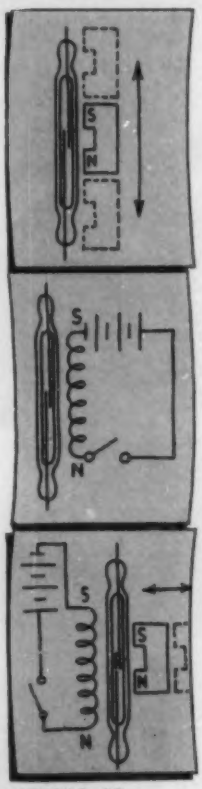
LIGHTNING RESPONSE . . . SEALED IN GLASS

The magnetically actuated reeds in this tiny Revere GLASWITCH make contact in just 1 millisecond . . . at rates up to 400 cycles per second. Hermetically sealed in an inert, dry atmosphere, with lightning fast snap action, both shelf and contact life are extremely long. Smaller than a cigarette, the GLASWITCH can be located anywhere . . . in any position . . . even in explosive atmospheres . . . individually or in multiples for multi-contact use.

Whenever you need faster, more positive response . . . where extreme sensitivity is a must . . . where light weight is important . . . investigate the Revere GLASWITCH. Write today for complete specifications and suggested uses.

CHARACTERISTICS:

Type—Single pole single throw—normally open—snap action
Enclosure—Hermetically sealed glass tube containing inert dry atmosphere
Operating Time—1 millisecond
Operating Rate—Up to 400 cycles per second
Contact Surfaces—Electroplated Rhodium
Contact Resistance (measured terminal-to-terminal)
Closed Circuit—0.050 ohms maximum
Open Circuit—500,000 megohms minimum
Contact Ratings
D.C. Loads at 28 volts
0.5 amps resistive
0.5 amps inductive (L/R—0.026)
A.C. Loads at 115 volts, 60 cycles
10 watt lamp load
Ambient Temperature Range— —85°F to +500°F



METHODS OF ACTUATION:

A moving permanent magnet or controlled external electromagnetic field are all you need . . . and the sky's the limit on imagination!

* Trademark

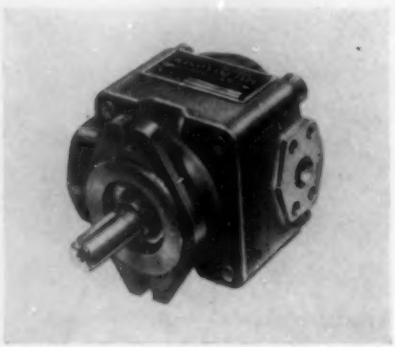
Revere CORPORATION OF AMERICA

WALLINGFORD, CONNECTICUT A subsidiary of Neptune Meter Company

piping. The external tube protects the inner operating cylinder and other working parts from possible stone damage.

The new booster is available with either of two piston strokes. Model 85 has a maximum stroke of 8½ in.; Model 105, 10½ in. Both have the same rated thrust capacity of 1500 lb at 600 psi operating pressure. The new booster is designed for a maximum operating pressure of 1000 psi. Vickers, Inc., 1400 Oakman Blvd., Detroit 32, Mich.

For more information—
Circle 99, inside back cover



Dual Vane 2000 Psi Pump

This pump is designed for high speed direct engine drive. Built to withstand continuous operation at 2000 psi, the new pump has a rated capacity of 3 to 11 gpm at 1200 rpm, but may be operated at speeds from 400 rpm up to 2000 to 2600 rpm depending upon pump size. All standard SAE and industrial mountings and piping provisions are available, as well as complete flexibility of port positions. New York Air Brake Co., Cleveland, Ohio.

For more information—
Circle 100, inside back cover

Clamp-Type Air Cylinders

A clamp-type air cylinder with universal mounting is now available in 2 in. bore size, 1 and 2 in. stroke lengths. Quick, easy mounting or removal from jigs and fixtures is said to be provided by a one-piece aluminum casting, which has a flat base for either horizontal or vertical mounting. Holes are slotted so cylinder can be installed, re-located or removed by merely loosening hold-down

Clarity plus strength can give you ideas,* too

For instance, KRENE Cast Vinyl Film can make practical windbreaks and side curtains for jeeps and tractors . . . excellent clarity gives unrestricted vision . . . high tear strength resists cracking, breaking or puncture.

Or: to keep dirty feet and sticky hands off beautiful upholstery, how about furniture covers of KRENE Cast Vinyl Film. All the color shows through . . . it's highly rub and scuff resistant . . . and cleans off with ease.

There are interesting fabricating possibilities also. For example, here's a sketch of a huge seven-foot beach ball made of KRENE Cast Vinyl Film. Large uses are easier because the film comes in long continuous lengths and up to 48 inches in width, and is easily heat-sealed.

KRENE Cast Vinyl Film is cold-resistant as well as unaffected by food chemicals. For example, fancy desserts can be made with attractively-designed "molds" made of this film. Pour a pudding or an ice into the container and put in the ice-box to set.

*about KRENE® Cast Vinyl Film

Why not investigate this unusual flexible film with an eye to your own products? Its unusual strength combined with window-like clarity and gloss is unique. It's available in thicknesses from .001 to .012, and with a variety of stiffnesses. For samples, and an informative booklet about KRENE Cast Vinyl Film, write Dept. ID-145.

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Krene®

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EASING DOWN 50 TONS OF AIRCRAFT

"We want to drop a 100,000-pound weight 4 feet at a speed of 12 feet a second... and do it so gently that even a full cup of coffee won't spill a drop!"

Cleveland Pneumatic engineers solved the problem. Our shop is building the shock absorbers (or "landing gears") for the customer's 58-passenger, four-engine airliner right now.

The principles we have developed to land tons of aircraft at high speeds smoothly are now being adapted to the solution of complex industrial shock and impact problems. If your problem hasn't responded to ordinary shock-absorption devices, let Cleveland Pneumatic engineers tackle it.

Write for "Booklet E-655" which describes some typical Cleveland Pneumatic solutions to shock-absorption problems. Or tell us your complex impact problem in as much detail as possible.

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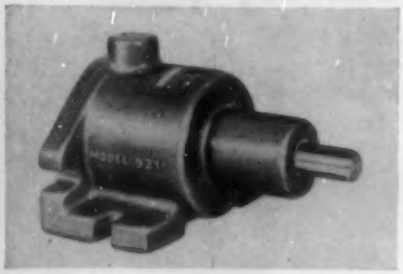
AIRCRAFT GROUND HANDLING EQUIPMENT
BALL-SCREW MECHANISMS • AIR-OIL IMPACT ABSORBERS

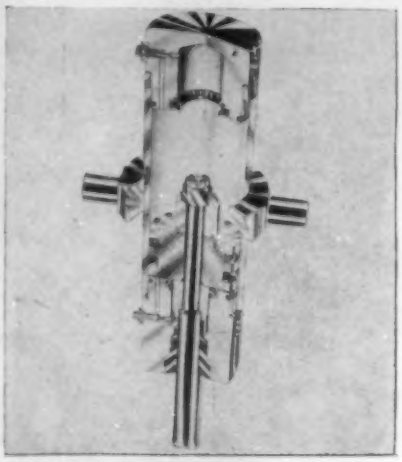
WORLD'S LARGEST MANUFACTURER OF AIRCRAFT LANDING GEARS



bolts. Cylinder's overall length is 4¾ in. for 1 in. stroke, 5¾ in. for 2 in.

Cylinder is spring-return type, normally retracted. Stainless steel piston rod is ½ in. dia and extends ⅞ in. in retracted position. Air connection is ⅛ in. female thread. Modernair Corp., 400 Preda St., San Leandro, Calif.

For more information—
Circle 101, inside back cover



Cylinders for Air or Oil

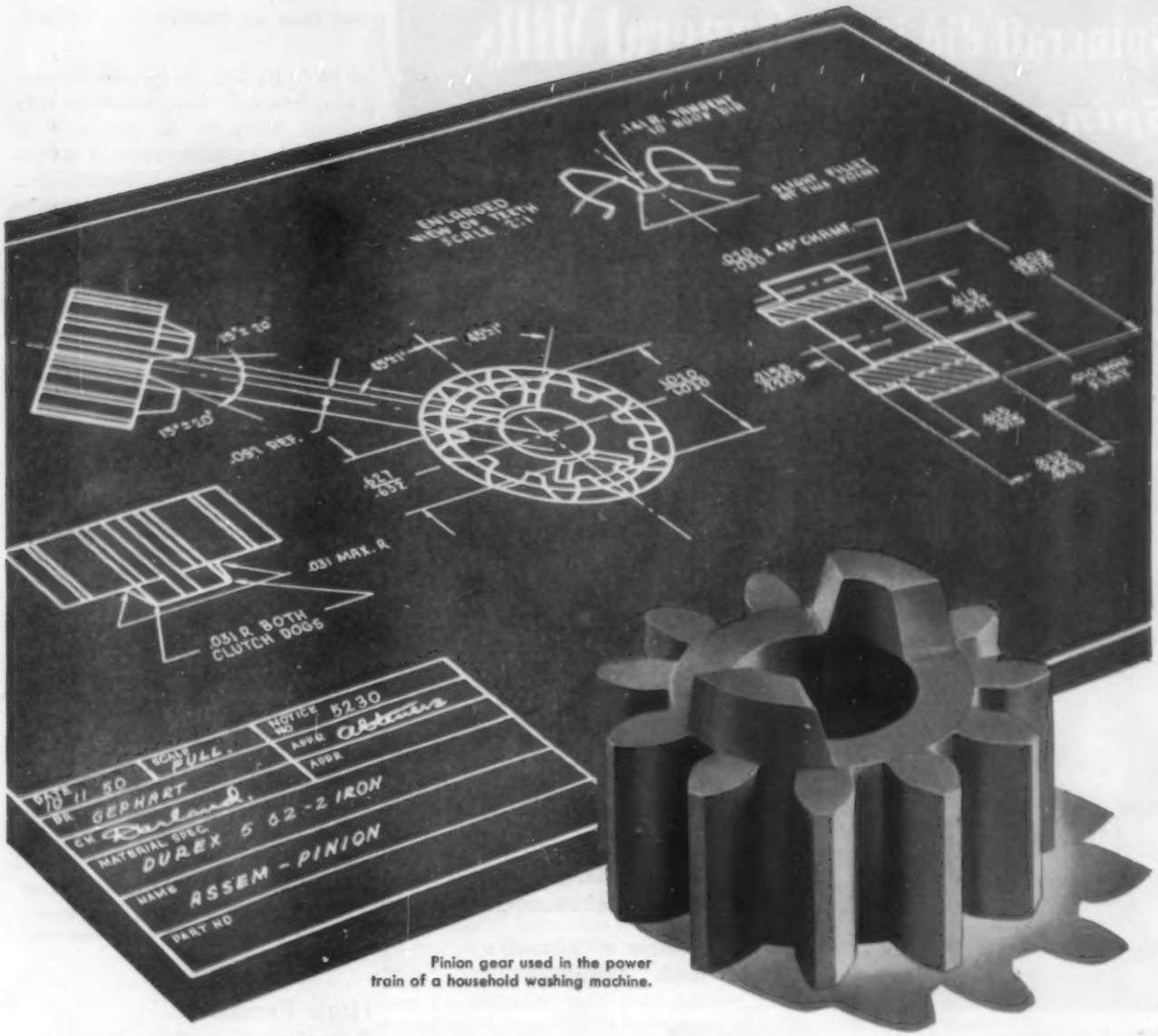
These cylinders have chrome-plated bodies and piston rods, solid steel heads and a heavy wall, seamless steel body. It is suitable for air pressures to 200 psi, oil pressures to 750 psi.

Various mounting styles, bore diameters to 5 in., inclusive, strokes 1 to 20 in. in ½ in. increments are available. Thomkins-Johnson Co., Jackson, Mich.

For more information—
Circle 102, inside back cover

Air and Hydraulic Booster Cylinder

An air and oil-operated booster cylinder that builds up fluid pressure to 1951 psi using an input pressure of 100 psi, or as high as 1660 psi using an input of 80 psi, develops a ratio of 19:7. Its 5-in. air cylinder drives a



Pinion gear used in the power train of a household washing machine.

MORAINE METAL POWDER PARTS SOLVE MANY PRODUCTION PROBLEMS

Here you see a complex design that is being mass-produced today by metal powder techniques *with important savings in cost.*

The print in the background indicates the intricacy of the design, while the photograph in the foreground shows the part ready to be assembled into the final mechanism. And from raw material to what you see here took only *one press operation!* This demonstrates what has come to be expected through cooperation between customer and Moraine.

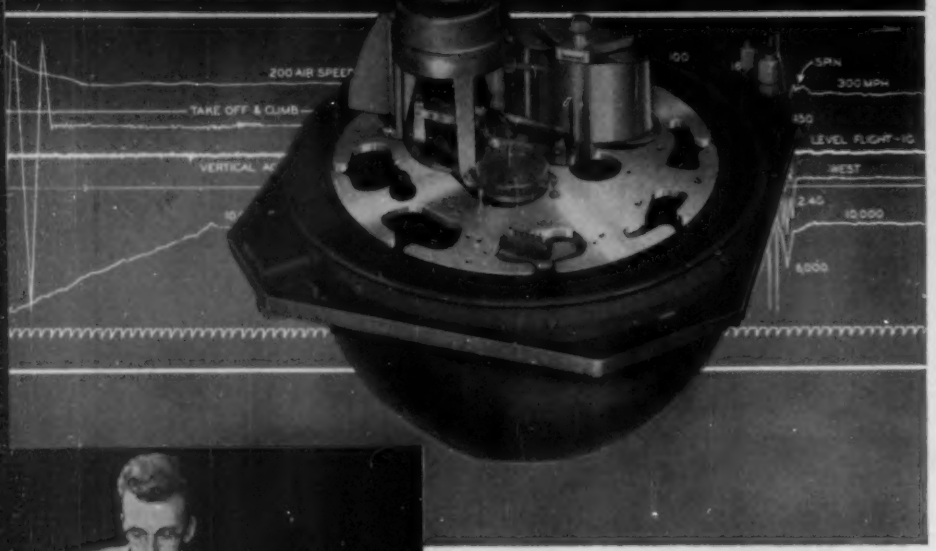
Moraine's experience with metal powder is called upon almost daily to resolve complex designs into economical production jobs—just as Moraine almost daily contributes to modern industry by improving product performance and lowering costs.

moraine products
DIVISION OF GENERAL MOTORS, DAYTON, OHIO

METAL POWDER PARTS

Spincraft did it for General Mills

Spincraft can do it for you!



Spun spheres protect mechanical fingers of world's toughest recorder

another example of Spincraft's "start-to-finish" fabrication

15 Different Operations —

The sphere, protecting the delicate sensing instruments, is completely fabricated by Spincraft. The sphere consists of an outer steel and inner aluminum shell separated by insulating material. The two hemispheres are joined together by an ingenious locking and sealing arrangement. Spincraft's complete fabricating responsibility involved spinning, machining, arc-welding, spot welding, brazing, grinding, sawing, drilling, braking, stamping, phosphate plating, anodizing, painting, assembly and pressure testing. Craftsman (above) is shown assembling a Flight Recorder.

This aircraft Flight Recorder, manufactured by the Mechanical Division of General Mills, etches a continuous 300-hour record of heading, air speed, vertical acceleration and altitude on aluminum foil. Each Recorder is fully-enclosed and protected in a specially fabricated sphere — made by Spincraft. The recording device, when enclosed in the sphere, is designed to withstand shocks of 100G's and resist temperatures of 2000°F up to 30 minutes.

This is another example of Spincraft's versatility and manufacturing skill. We offer complete facilities for contract manufacture of finished parts, assemblies and complete products.

Take advantage of our modern tools for spinning, deep drawing and stamping as well as complete fabrication. They can pay off in savings for you.

Write for Spincraft data book. If you have a specific problem, tell us about it — no obligation.

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of 19.7. Its 5-in. air cylinder drives a 1¼-in. hydraulic ram, which in turn delivers 0.994 cu. in. per inch of stroke. The cylinder return is accomplished by air action. Airmatic Valve, Inc., 7317 Associate Ave., Cleveland 9, Ohio.

For more information— Circle 103, inside back cover

Hydraulic Cylinders of 1½ to 5 in. Bore

These cylinders are being manufactured in quantity from 1½ to 5 in. bore, strokes to 10 ft. Cylinders for agricultural uses have a working pressure of 1500 psi, cylinders for industrial applications, a 2500 psi. pressure. They are constructed of seamless tubing with aluminum pistons and heads. A variety of end fixtures, packings and accessories are available. Hemco Mfg., Inc., Argonia, Kansas.

For more information— Circle 104, inside back cover

High Pressure Rotating Swivel

Designed particularly for applications in the brake and clutch field, this swivel is equipped with spring-loaded Teflon rings, self-centering thrust ball bearings and axial bearings. It measures 3 x 1¼ in. Hydraulic Unit Specialties Co., Waukesha, Wis.

For more information— Circle 105, inside back cover

Couplers and Connectors For Air-Operated Equipment

Coupler valve gives higher volume air passage, is said to remain airtight under high pressure and is made of stainless steel to resist moisture in air lines. Coupler is linked to compressed-air source with hose or tubing, and connector is attached to air-operated equipment. Plug-in action snaps coupler and connector together, without

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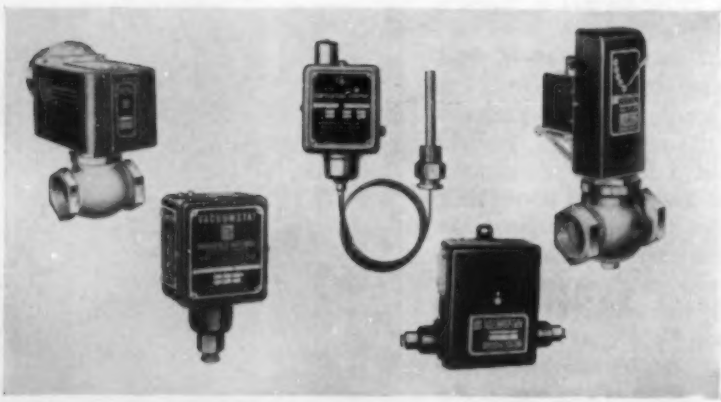

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Minneapolis-Honeywell Regulator Co.
Wayne and Windrim Aves., Philadelphia 44, Pa.

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need of twisting or turning. Swivel action of coupler prevents kinking of hose.

Available in range of sizes and inlets for ¼, ⅜, ½ in. hose. Aro Equipment Corp., Bryan, Ohio.

For more information—
Circle 106, inside back cover

End Mount for Hydraulic Cylinders

This end mount was designed especially for use on machine tools with long sliding beds. Mounting and porting are so arranged that the cylinder can be removed by disconnecting two tube fittings in the end cap and removing four mounting bolts. When this is done the entire unit may be lifted out.

According to the manufacturer, this new end mount can be adapted to any machine where the special cylinder can be replaced with this cylinder adaption. Hydro Line Mfg. Co., 5742 Pike Road, Rockford, Ill.

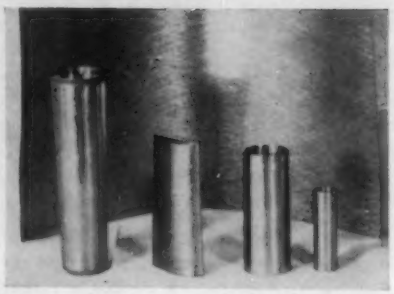
For more information—
Circle 107, inside back cover

Flow Volume Control

A control that delivers a set rate of fluid flow, regardless of variable inlet pressures, operates by harnessing the pressure and putting it to work to control itself through flexing a molded neoprene diaphragm into the machined grooves and hole of a brass orifice plate. It has only one moving part. Hays Mfg. Co., Dept. 217, W. 12 St., Erie, Pa.

For more information—
Circle 108, inside back cover

ENGINEERING MATERIALS



Porous Metal Made from Wire

This ductile, non-shedding porous metal made from wire is said to have tensile strengths as high as 85,000 psi when made in stainless steel. It is available in most metals and alloys and may be obtained in seamless tubing from ⅛ to 18 in. dia and in sheets as large as 18 x 54 in.

Pore path and shape are controllable and air flow rates as high as 150 fps under a pressure of 1 psi are possible with this new material. Particles smaller than 5 microns are removed with an efficiency of over 90 per cent, according to the manufacturers. Material is made by winding wire in overlaid layers on a mandrel. Poroloy Equipment, Inc., 12270 Montague St., Pacoima, Calif.

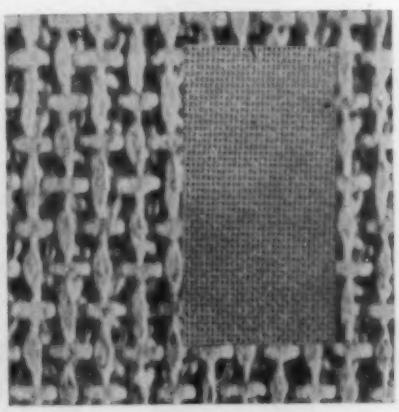
For more information—
Circle 109, inside back cover

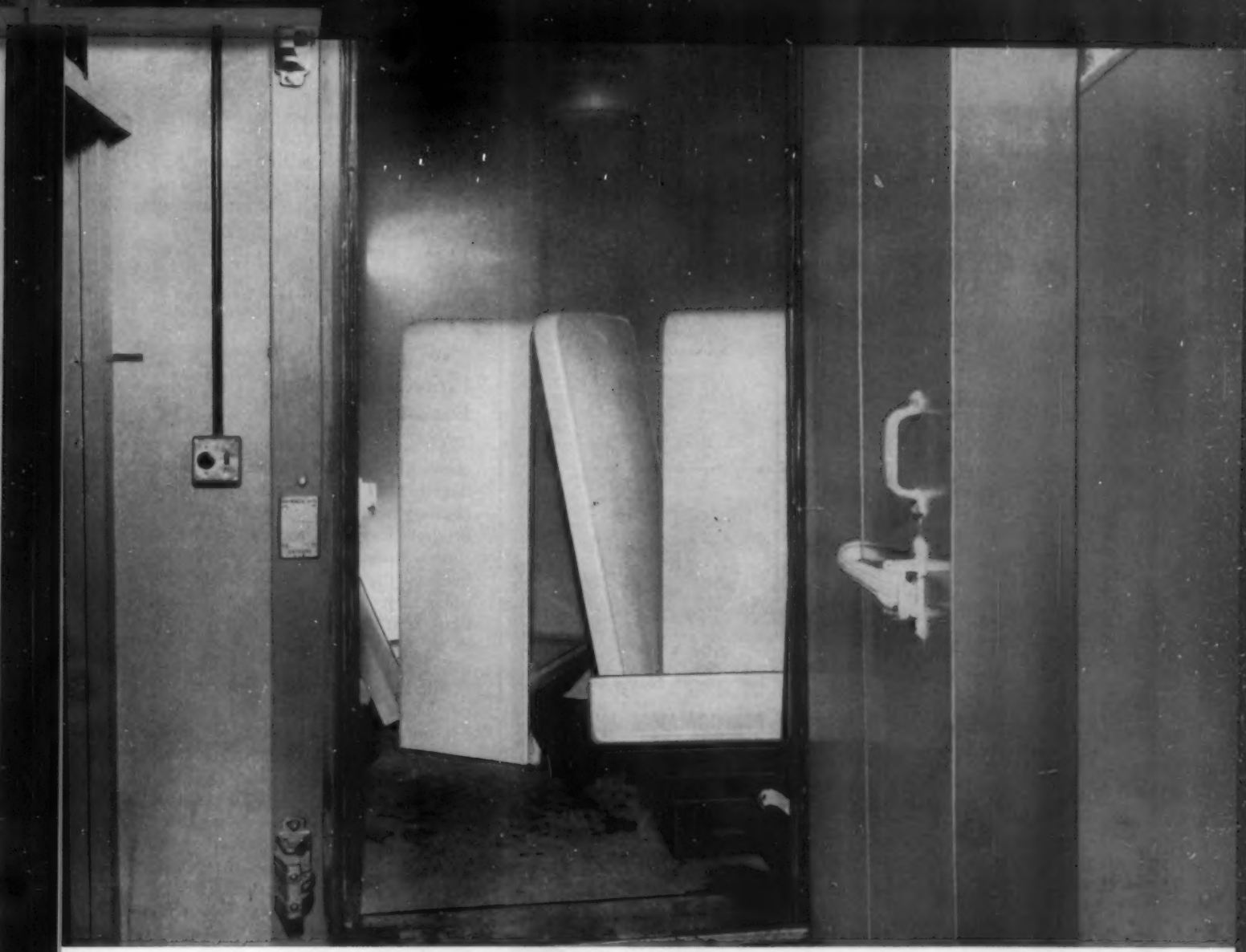
Porous Silver Bearing Liners

The advantages inherent in the use of silver as a sleeve bearing material have been known for years. Silver-lined sleeve bearings are, for example, used for heavy duty applications in aircraft.

This newly developed porous silver liner is made using sintered wire and can be made to carry bearing loads as high as 50 to 75 per cent of those of solid silver. Void content can be in the range 10 to 50 per cent. Impregnation with various lubricants can readily be accomplished.

The material is available in the form of flat sheet, to be formed by the





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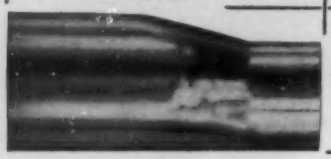
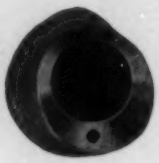
TOP VIEW



FRONT VIEW



SIDE VIEW

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There are engineers with three dimensional cam problems who are unaware that their difficulties can be overcome—that Parker can design a single cam with an infinite number of exact stations—then reproduce thousands of absolutely identical duplicates to control relative motions through geometric and non-geometric curves in three dimensions.

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customer into half or full bearing liners. If preferred, it can be supplied as completed bearings, fitted into a steel housing. Micro Metallic Corporation, 30 Sea Cliff Avenue, Glen Cove, New York.

For more information—
Circle 110, inside back cover

Protective Coating For Metals

A coating for metals that preserves chemically cleaned surfaces obtained directly after electroplating or a chem-cleaning operation can be sprayed on or applied as a dip after a final water rinse without drying. This is possible because the new material displaces water as it deposits a thin protective film. It is reported that after 210 hr of an ASTM salt spray test, no corrosion was found on coated parts.

The same electrical resistance is provided as an oxide film that requires 8 hr to form on aluminum at room temperature. This resistance remains constant with aging. A film of 0.0001 in. has an electrical resistance of 0.2 ohm at 1½ v and does not interfere with electrical connections, wiring, or parts attached to a chassis that must remain in electrical contact. Fidelity Chemical Products Corporation, 470-474 Frelinghuysen Avenue, Newark, New Jersey.

For more information—
Circle 111, inside back cover

Stainless Steel 400 Mesh Cloth

Stainless steel wire cloth of 400 mesh is being woven of 0.001 in. wire. Openings are 37 micron. This cloth is woven to a standard 24 in. width. Newark Wire Cloth Company, Newark, New Jersey.

For more information—
Circle 112, inside back cover

Porous Aluminum

Porous aluminum and aluminum alloys with controlled pore size have now been made in a range of thicknesses in excess of ⅛ in. Various types of porous sheet aluminum made thus far reveals pore openings of from 5 micron for the finest grade to 150 micron for the coarsest, all with uni-

form porosity. A wide range of flow capacities for liquids and gases is possible.

Porous aluminum can be readily formed and welded thereby providing a wide latitude in application. The porous metal has chemical properties equal to those of solid aluminum of comparable alloy composition. Micro Metallic Corp., 30 Sea Cliff Ave., Glen Cove, N. Y.

For more information—
Circle 113, inside back cover

Magnesium-Thorium Alloy Sheet

Now being rolled into sheet and plate, the thorium alloys of magnesium were formerly available only as castings. They are said to have excellent tensile strength and creep resistant properties in the 300 to 700 F temperature range. In this regard they are superior to any of the alloys of aluminum and to any other magnesium alloys. Brooks and Perkins, Inc., 1950 W. Fort St., Detroit 16, Mich.

For more information—
Circle 114, inside back cover

Glass-Reinforced Molding Materials

A fully loaded glass-modified material is part of a new series of glass-reinforced phenolic molding materials developed. Two glass-and-cellulose materials are presently available. Available as sheets and blanked preforms, the materials lend themselves to standard molding operations, high-speed tapping and the molding-in of inserts. Rogers Corp., Rogers, Conn.

For more information—
Circle 115, inside back cover

Embossed Steel Sheet and Coils

Available in coil or sheet form, in any length and in widths up to 48 in., the embossed pattern shapes the entire cross-section of the metal. This is asserted to give it 25 per cent greater strength and rigidity without added weight. The material is furnished in mild steel, stainless steel and aluminum, thicknesses varying according to the metal used. It can be formed,

HOT OR COLD
from Drying Ovens to Ice Flakers

SAVE SPACE WITH
WINSMITH
SERIES "C" SPEED REDUCERS!

This view of the mounting arrangement in the Scotsman Ice Flaker, shows the 10" pulley attached to the high speed shaft of the reducer.

For *every* speed reducer application where space is at a premium, you'll put a premium on the new Winsmith Series "C" Speed Reducers. With this series, Winsmith achieves stepped-up horsepower and torque output without increase in overall size. Pricewise, this means that the "C" Series Reducer gives you more value than ever offered for your horsepower dollar.

The streamlined Scotsman Ice Flaker, manufactured by the American Gas Machine Company, is an example of how one manufacturer uses Series "C" Reducers to make every inch of space count. Because of *compactness*, the model "CT" reducer has been selected for use on the complete Scotsman Line. And, equally important, — *trouble-free operation* — is another reason the American Gas Machine Company gives for selecting this series!

Driven by a ¼ hp motor at 1725 rpm, with a reduction ratio of 49 to 1, these "CT" reducers are helping to build a splendid reputation for Scotsman Ice Flakers in thousands of restaurants, hotels, hospitals and institutions throughout the country.

Whatever your products may be — from drying ovens to ice flakers — if you're designing for more streamlined appearance, or, if you're aiming at reducing component size without sacrificing performance, then you should get the complete facts on the Winsmith Series "C" Reducers. Write today for Bulletin HW-654.

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Glass bottles! The average American uses 118 a year. That's 18 billion in all. More and more are being made faster, tougher, and better, at less cost, with the help of LINDE Silicones.
PERFUME
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LOOK AT the reasons why

Leading glass makers are welcoming a type of LINDE Silicone that helps them produce bottles sparkling clean—with fewer rejects. It is simply sprayed on molds, shear blades, and chutes. Its cleanliness improves the product. With no soot and smoke, working conditions are better.

But helping glass serve the tremendous business of bottling America's medicines, beverages, cosmetics, foods, is only one of the achievements of LINDE silicones. Many other industries are taking advantage of the "slipperiness," the strong resistance to heat and cold, the water repellency, and other useful qualities of this versatile family of chemicals.

Because LINDE and other divisions of UNION CARBIDE serve customers in so many fields, LINDE is particularly qualified to supply and help you use silicones that can improve your products or processes, and reduce their costs. Write Dept. P-6.

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stamped, crimped, punched, welded, riveted, drilled, sheared or roll-formed without any effect on the pattern. Sun Steel Co., 1702 W. 74 Pl., Chicago 36, Ill.

For more information—
Circle 116, inside back cover

Plastic Pipe and Fittings

A line of polyethylene pipe and modified polystyrene insert fittings is available in sizes ranging from ½ through 2 in. It is coiled in lengths, varying with the pipe size, from 100 to 400 ft. The basic fittings, made of modified polystyrene, are insert-type ells, tees, couplings and adapters. A 400-ft coil of ½ in. pipe weighs only 40 lb. Crane Co., 836 S. Michigan Ave., Chicago 5, Ill.

For more information—
Circle 117, inside back cover

Thread Sealing Compound

Recommended for pipes carrying volatile acids, alkalies and solvents, this compound is chemically and biologically inert and can be used continuously from −150 F to 500 F. Equipment can be readily dismantled after intensive use. Gilbreth Company, 1211 Chestnut Street, Philadelphia 7, Pennsylvania.

For more information—
Circle 118, inside back cover

Polyethylene Wax

This synthetic wax will be available in small pellet form about the size of a grain of rice, packaged in 50 lb paper bags. Regular waxes are handled either in large blocks weighing 10 to 12 lb, or in broken slabs. Blocks and slabs generally reach the user in 200 lb bags or drums. The new polyethylene wax is available in two forms at present: 1) An emulsifieable type; 2) a non-emulsifiable type.

Both forms of the wax are compatible with all commonly used animal, vegetable and mineral waxes, with the exception that "Epolene-N"" is incompatible with certain of the components of candelilla and ouricury. Eastman Chemical Products, Inc., 260 Madison Ave., New York, N. Y.

For more information—
Circle 119, inside back cover

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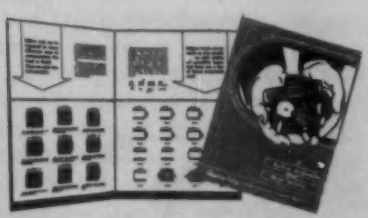

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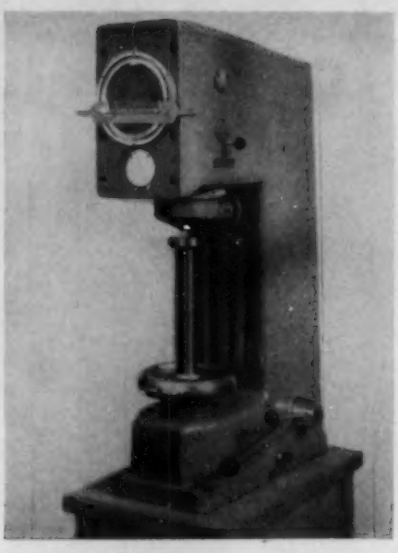

Optical Hardness Testing Machine

This micro hardness testing machine is made in two models. The light-load machine can handle a minimum proof load of 300 g, the larger one can reach down to 50 g. (This refers to load applied to Brinell ball.)

The unit is contained in a housing which conforms to the shape and size required for a normal lens mounting. A single arm crank carried on a knife-edge bearing has suspended from its end (which is outside the housing) a plate for the loading weights; in the center of the housing, suitably carried on a knife edge, is the weight that presses the diamonds into the sample. The changeable load weights have been selected so that all proof loads between 50 and 500 g can be increased in 50 g increments. With this construction, the manufacturer reports, the load transfer is achieved with the most exact balance even at the highest possible friction.

This instrument is offered with a microscope, but it can also use the lens mount of any conventional microscope that has an objective revolving barrel. This gives the instrument a correspondingly wider range of application without the expense of large investment in lenses.

During the taking of measurements, the zero point and also the reading of the measurement remains in the field of view.

After placing a specimen on the hardness tester's microscope table, (a variety of special holders are obtainable), the desired field of measurement is centered under the objective lens. The diamond holder with the selected weight load is now brought over the specimen and through the means of the coarse or the fine drive is pressed into the specimen. The movement of the load lever shows the operator the amount of indentation upon the specimen. After adjustment of the microscope slide to a sharp focus, the selected objective is again swung into place. Now through the medium of the optical micrometer the exact measurement of the impression, which in many instances is not visible with the naked eye, is determined. The relationship between the impression diagonal and the hardness is then determined through the tables which accompany all equipment. This equipment can be used for: 1) Hardness determination of thin sheet metal; 2) investigations of hard skins such as nitriding; 3) hardness determinations of galvanic coatings; 4) hardness determinations of ceramics, such as glass, porcelain; 5) hardness determinations of coating tools: 6) hardness testing of soldered and brazed joints; 7) investigations of hardness distribution of cold-formed pieces; 8) investigations of the hardness of powder pressings and sintered materials; 9) identification of crystals through comparisons of hardness. Karl Frank GMBH, Weinheim-Birkenau – 17A, Germany.

For more information—
Circle 120, inside back cover

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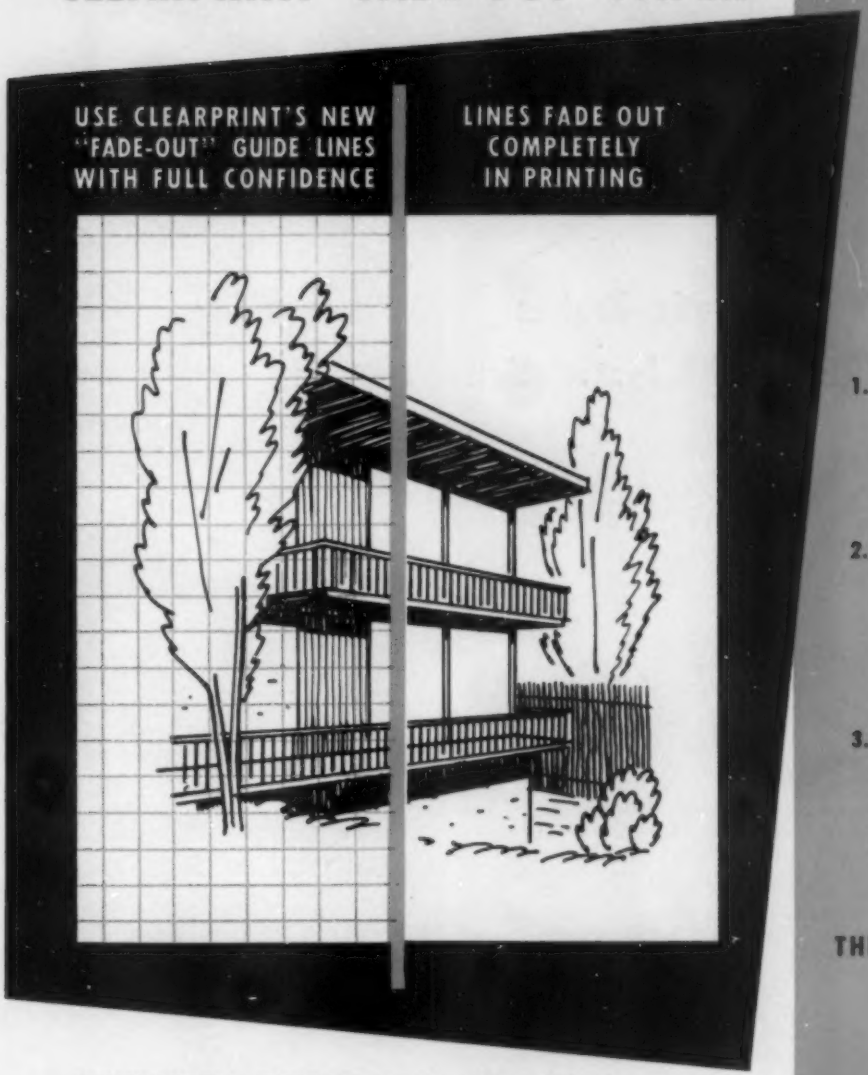

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Dings *Direct Acting* Magnetic Disc Brakes can be installed anywhere a shoe brake is used and in addition can be installed where a shoe brake is not suitable because of appearance and space considerations.

Be sure to *specify* Dings Magnetic Brakes to meet your needs, from your regular motor supplier. While these efficient units are easy to select and apply, Dings offers complete engineering service to help solve your specific brake problems. *Write for Bulletin* BK4002.

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db INC

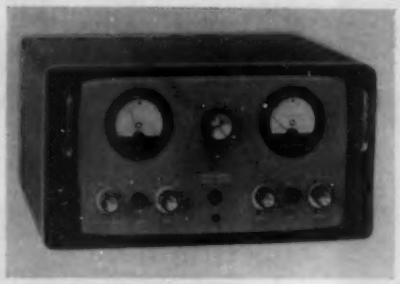
See our Catalog in SWEETS PRODUCT DESIGN FILE—Section 5a/Di.

D8355½

of chemicals or the use of liquids in trays.

The new whiteprinter is being made in three sizes to produce white copies from a minimum of 18 in. to a maximum of 42 in. wide. Rotolite Co., Basking Ridge, N. J.

For more information—
Circle 121, inside back cover



Power Supply Provides 0.001 Per Cent Regulation

This power supply provides up to ½ amp, dc, at 0 to 500 v with less than 100 microvolt of ripple. The d-c and low frequency impedance is less than 0.005 ohm. The a-c impedance is less than 0.05 ohm in series with 0.1 microhenry (4 in. of wire). Transient response is 0.001 millisecond. Typical 10-hr drift is 300 ppm plus 20 millivolt. Dimensions are: 17½ x 9 x 15½ in. deep—also available for rack mounting. Krohn-Hite Instrument Co., 580 Massachusetts Ave., Cambridge 39, Mass.

For more information—
Circle 122, inside back cover

"Stackable" Regulated Power Supply

Although the basic output range is 200-325 v at 0-100 ma, two, three or four units can be "stacked" in parallel to furnish 0-200 ma, 0-300 ma or 0-400 ma. "Hogging" of the load by one supply in a stack is said to be pre-

CUT PIPING COSTS

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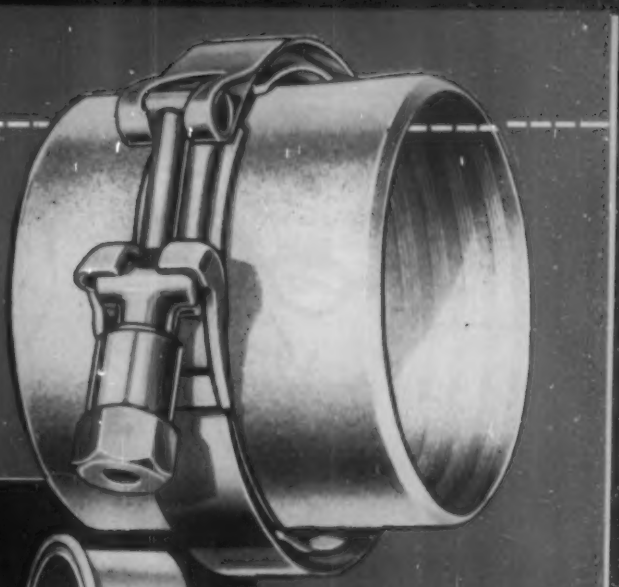
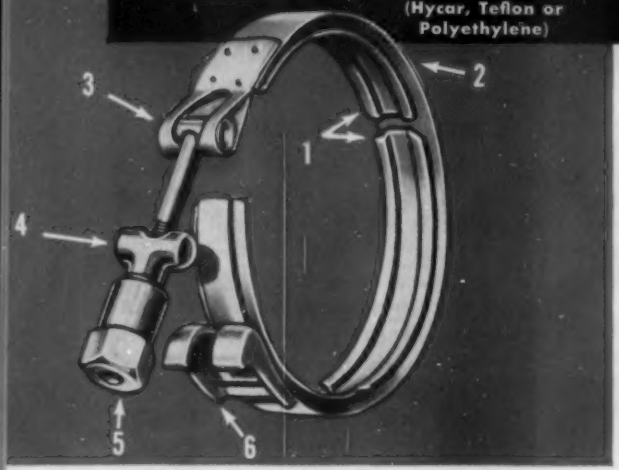
TRI-CLAMP

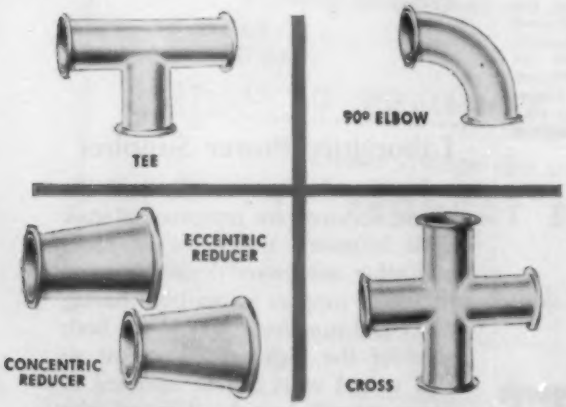
Schedule 5-10 and Tube O.D.

STAINLESS STEEL INDUSTRIAL FITTINGS





Tri-Clamp Industrial Type Stainless Steel Fittings are available in all standard types, in sizes from 1" through 12". Fittings are fabricated from type 304 and 316 stainless steel, and sizes through 4" are annealed, pickled and passivated.



. . . Send for NEW Bulletin . . .

Complete details on TRI-CLAMP Industrial Type Stainless Steel Fittings are covered in the new Bulletin 1055. Send for your copy now.

Simple Rugged Construction Assures Fast Positive Leak-Tight Joints

1. **RETAINER SECTIONS** grip flanged ferrules securely, assures proper alignment.

2. **TENSION BAND** equalizes pressure around joint, holds clamp in position for quick connection.

3. **TRUNNION** is of simple design, provides fast locking and unlocking action.

4. **"T" LATCH** assembly easily snaps into position in Coupler (6) and is held in position by tightening nut (5).

5. **TENSION NUT,** easily tightened with ordinary hex wrench.

6. **COUPLER SEAT,** holds Latch securely in place to complete positive, leak-tight joint.

As illustrated, the TRI-CLAMP Joint consists of a flange type ferrule—a special precision molded gasket which fits into the grooved ferrule lip—and the TRI-CLAMP itself, which is composed of a specially fabricated spring clamp which grips the ferrule edges, and a simple, bolt-type coupler assembly firmly secured to the clamp ring . . . always in position for instant assembly or disassembly.

All that is necessary for installation is to attach the ferrules to stainless steel tubing or pipe, insert gasket into position, slip TRI-CLAMP over ferrules and gasket and tighten into closed position—to produce a positive, leak-tight joint.

TRI-CLAMP Stainless Steel Fittings offer an entirely new concept of fitting design and fabrication, offering much greater speed and ease of installation, together with appreciable savings in original investment cost, and longer trouble-free life for many types of corrosion-resistant liquid conveying line service.

See your nearest Tri-Clover distributor, or write:

LADISH CO.
Tri-Clover Division
Kenosha Wisconsin

EXPORT DEPT., 8 So. Michigan Ave., Chicago 3, U.S.A.

1355

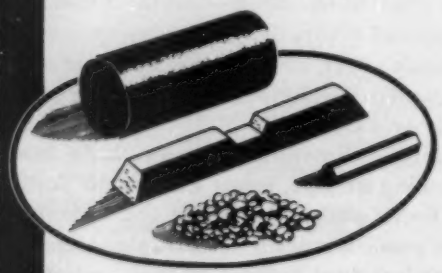
Here's help for exacting engineers and production men . . .

who must be absolutely right about metal analysis

WITH each MasterMet alloy you buy, Cannon-Muskegon gives you a certified, notarized analysis . . . black-on-white proof that MasterMet alloys are produced exactly to your specifications. This assures close predictable control of physical and chemical characteristics for any end-use. You can be confident that the results you plan — the performance you call for will be delivered in parts made with MasterMet alloys.

You can choose from a wide range of high alloys including cobalt-base and nickel-base alloys, chromium and chromium nickel stainless steels. Also included are such special alloys as Monel*, Inconel*, Invar, Ni-Resist*. Order these types or your custom specifications from Cannon-Muskegon.

*Trademark — International Nickel Co.



FOR REMELT OR PROCESSING

MasterMet alloys are available in shot, ingots and cast billets, bars and special shapes. Often the more common low alloy and 300 and 400 Series stainless steels can be shipped from stock. Remember . . . whatever your needs, Cannon-Muskegon can provide metallurgical engineering assistance in recommending the proper alloy — as well as the proper handling — to assure the best possible casting. Write for bulletin!

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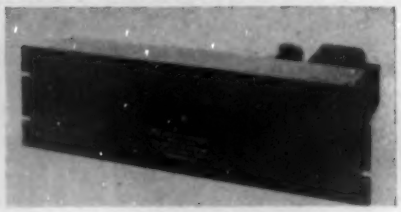
MASTERMET
CERTIFIED ALLOYS FOR INDUSTRY



vented by a special circuit arrangement. The junction between the pass-tube grids and the error-amplifier plate is brought to the rear terminal strip, permitting several units to be interconnected so that one error amplifier controls all the pass-tubes in use while the other error amplifiers remain inactive. In addition, this setup permits the use of one voltage control to set all the supplies to the desired output. Load division is uniform to 10 percent. New Jersey Electronics Corp., 345 Carnegie Ave., Kenil worth, N. J.

For more information— Circle 123, inside back cover

Four and Six-Channel Portable Oscillographs

The four-channel oscillograph weighs 36 lb and the six-channel recorder is 48 lb. Each unit offers a range of 16 chart speeds with the travel variation of from 10 in. per day to 10 in. per sec to simplify the testing problems of electrical variables, vibration, torque, stress, strain and other desired mesaures.

Both models, equipped for either ink or electric writing, can record a greater range of signals with optimum resolution than other direct-writing oscillographs. Brush Electronics Co., 3405 Perkins Ave., Cleveland 14, Ohio.

For more information— Circle 124, inside back cover

Laboratory Power Supplies

Developed to provide the flexibility of use necessary for experimental work with klystrons, traveling-wave tubes and other microwave devices, a series of power supplies is available having 50-kv isolation from ground on both sides of the high voltage circuit so that several units can be operated in series where desired. Two of the models have continuously-variable outputs from 0 to 1000 v and from 0 to 2000 v at 200 milliampere. Larger-ca-

DESIGNING WITH ALUMINUM

NO. 13

This is one of a series of information sheets which discuss the properties of aluminum and its alloys with relation to design. Extra or missing copies of the series will be supplied on request. Address: Advertising Department, Kaiser Aluminum & Chemical Sales, Inc., 1924 Broadway, Oakland 12, California.

COLOR MATCHING OF ANODIZED ALUMINUM ALLOYS

COLOR MATCHING, in the sense of "tone" or "shade," among the various aluminum alloys can be rather complicated. The degree of complication depends greatly upon the type of finish which is desired for the various alloys which might be used in making up an aluminum assembly.

Generally, the appearance of various wrought and cast alloys will vary slightly in the mill-produced condition because of different alloy constituents at the surface. The simplest way to achieve the most uniform color among the various alloys is to polish them mechanically. Practically all freshly polished aluminum alloys look alike. However, ordinary weathering or aging in industrial atmospheres will cause slight surface film reactions. The products of these reactions will differ for the various alloys. Generally, aluminum alloys retain a bright pleasing appearance despite extended exposure to the weather. A few alloys will darken upon weathering.

Alloys that contain silicon, such as 4043, and those that contain copper, such as 2024, are among the alloys which darken rapidly upon exposure in the unprotected condition. There is no way to prevent this except by anodizing, chemically coating or painting.

Chemical conversion coatings, while often providing satisfactory protection from the environment, are not usually suitable for decorative applications. If a good permanent color is important to a design, and if painting is not desirable, anodizing is necessary. In a situation such as this a very careful selection of alloys must be made before anodizing in order to obtain a good color match —or contrast if it is desired. All alloys will exhibit slight to marked color differences after being anodized. Some alloys are fairly close in anodized color, especially when the anodic coating is not too thick. Figure 1 shows both matching and contrasting anodized aluminum alloys.

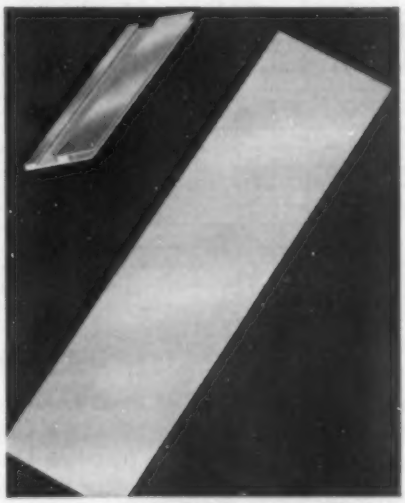


Fig. 1. Anodized 6063 extrusion alloy and 5005 sheet alloy lie side by side on a sheet of anodized 4043 sheet alloy which is quite dark. Notice that the 6063 and the 5005 match each other in color value but contrast sharply with the 4043.

A recognition of the technical principles which must be employed in the selection of the various alloys for color matching of their anodic coatings is of value in many applications of aluminum. In the architectural field alone the subject of color matching in anodized aluminum is assuming greater importance. Almost daily aluminum usage increases in such things as curtain wall construction. Table 1 lists many of the aluminum alloys in general use today and shows the approximate color matches obtainable through anodizing. For maximum color similarity slight variations in the anodizing process are necessary and should be established by the processor. The chemical compositions and tempers of the alloys are the basic reasons for differences in color after anodizing.

The commercially pure materials, such as 1100, EC, 1180 and the cladding material of Alclad alloy 2024, all exhibit relatively good color matches after anodizing. Those Alclad alloys which employ 7072 as the cladding, e.g. 3003, 3004, 5050, 6061 and 7015 will match well after anodizing. As a class, alloys containing magnesium provide relatively good matches, especially if the anodic coating is of moderate thickness. The magnesium content exerts a slight influence upon the color, but the purity of the alloy base is even more important. As a general rule, the higher the purity of the alloy base, the more transparent and the brighter the appearance of the anodic coating. Thus, anodized 5052 is brighter than anodized 5050.

Alloys containing copper, for instance 2014 and 2024, generally develop dark unattractive coatings when anodized in the annealed condition. The same alloys, when properly heat treated and quenched, may give relatively clear, attractive anodic coatings that will approximately match anodic coatings on alloys 1100 and 5005. A similar situation exists for 7075 alloy.

The high silicon alloys, such as No. 43 and No. 380 which are frequently employed in castings, present a very difficult problem since the silicon constituent darkens upon anodizing and, with sufficient anodic coating thickness, may be quite black. It is impossible to match such anodized casting alloys with most other aluminum alloys in the anodized condition. A match is possible with alloy 4043.

Aluminum casting alloys containing principally magnesium rather than silicon, on the other hand, match reasonably well with most other alloys. Casting quality and technique have an

PLEASE TURN TO NEXT PAGE

TABLE 1 **APPROXIMATE COLOR MATCHES OF ANODIZED ALUMINUM ALLOYS**

O = Relatively Good Matching X = Better Matching

	Sheet and Plate Alloys																Extrusion Alloys						Casting Alloys			
Sheet and Plate Alloys	1180	1100	2014*	2024*	Alclad 2024	3003	Alclad 3003	Alclad 3004	4043	5005	5050	Alclad 5050	5052**	6061	Alclad 6061	7075*	Alclad 7075	1100	3003	2024*	6061	6063	7075*	43	A214	A218	380
1180	X	O			O													O									
1100	O	X	O	O	X					O						O		X		O			O				
2014*		O	X	O						O								O		O					O	O	
2024*		O	O	X						O								O		X					O	O	
Alclad 2024	O	X			X													X									
3003						X													X								
Alclad 3003							X	X				X			X		X								O	O	
Alclad 3004							X	X				X			X		X								O	O	
4043									X															X			X
5005		O	O	O						X	O		O	X		O		O		O	X	X	O		O	O	
5050										O	X		O	O		O					O	O			O	O	
Alclad 5050							X	X				X			X		X								O	O	
5052**										O	O		X	O							O	O			O	O	
6061										X	O		O	X							X	O			O	O	
Alclad 6061							X	X				X			X		X								O	O	
7075*		O								O						X		O					X		O	O	
Alclad 7075							X	X				X			X		X								O	O	
Extrusion Alloys																											
1100	O	X	O	O	O					O						O		X		O			O				
3003						X													X								
2024*		O	O	X						O								O		X					O	O	
6061										X	O		O	X							X	O			O	O	
6063										X	O		O	O							O	X			O	O	
7075*		O								O						X		O					X		O	O	
Casting Alloys																											
43									X															X			X
A214			O	O			O	O		O	O	O	O	O	O	O	O			O	O	O	O		X	O	
A218			O	O			O	O		O	O	O	O	O	O	O	O			O	O	O	O		O	X	
380									X															X			X

* Heat treated and quenched ** For relatively thin anodic coatings, i.e., not exceeding 20 min anodizing

even greater influence on anodizing characteristics than does the alloy composition.

Among the sheet and plate alloys it is almost impossible to match alloys containing manganese, such as 3003, with other alloys as far as color in the anodized condition is concerned.

Some examples of compatible pairs for anodizing are 5005 and 6063, 5005 and 6061, 1100 and Alclad 2024. Numerous other examples may be chosen based on the principles outlined above. Of special interest to designers and engineers who are concerned with building materials and architectural design, is the excellent color match which may be obtained in the anodized condition with the sheet alloy 5005 and the extrusion alloy 6063. Alloy 5005 is a magnesium-containing alloy (nominal 0.8% Mg) with strength and formability approximately equal to those of 3003 alloy. Alloy 6063 is the extrusion alloy which is employed almost universally in window frame molding and store front trim. Where an architect wishes to use an anodized sheet product close to an anodized 6063 extrusion, a definite clash in color will result if alloy 3003 is employed as the sheet material. However, alloy 5005 when employed in place of alloy 3003, exhibits an excellent color match with 6063 when both alloys are anodized to the same coating thickness.

The understanding and application of the principles affecting the colors of anodized aluminum alloys will provide the means for attractive architectural design work. These same principles will undoubtedly influence the choice of aluminum alloys for products outside the field of architecture.

Further information concerning the color matching of anodized aluminum alloys may be obtained from the Kaiser Aluminum sales office listed in your telephone directory, or through one of our many distributors. Kaiser Aluminum and Chemical Sales, Inc. *Executive Office:* 6679 Kaiser Building, Oakland 12, California; *General Sales Office:* Palmolive Building, 919 North Michigan Ave., Chicago 11, Illinois.

Kaiser Aluminum

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pacity units of similar design up to 50 kv are also available.

Operable from inputs of 105 to 125 v, single-phase, 60-cps power, these two supplies exhibit regulation to a maximum of ½ per cent over that input range, and ripple of less than 0.5 v. peak-to-peak at any output. Levinthal Electronic Products, Inc., 2981 Fair Oaks Ave., Redwood City, Calif.

For more information—
Circle 125, inside back cover

Twin Transistor Power Supply

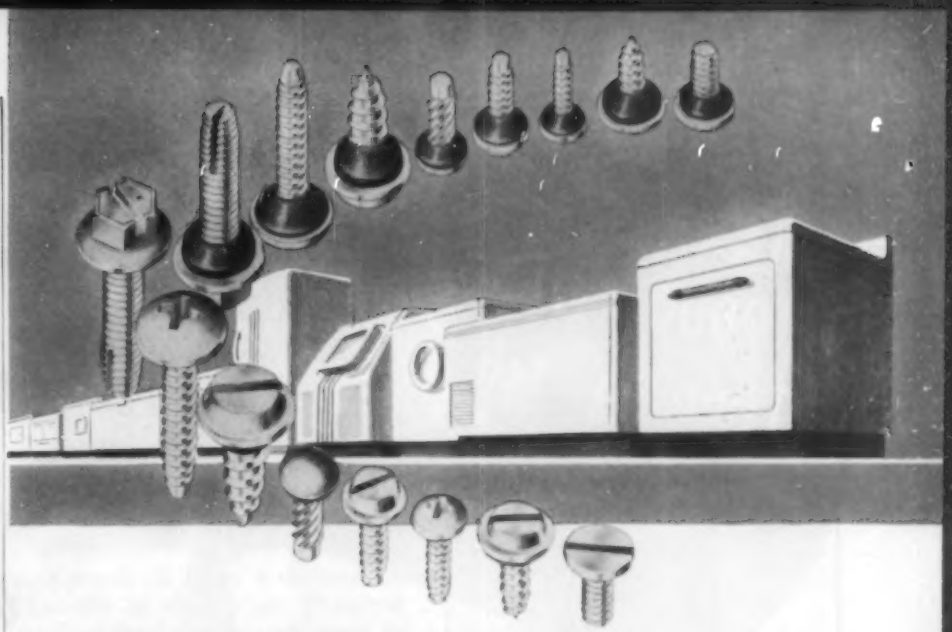
This regulated d-c supply has been developed specifically for use in transistor circuit development. The unit has a regulation of better than 0.1 per cent for ±10 per cent line variation or zero to full load current change. The output of each of the transistor supplies is 0 to 10 and 0 to 100 v, controlled by a ten-turn helipot. In addition, two more outputs of 6.3 v, ac, at 8 amp each are provided to increase flexibility of application for other, non-transistor applications. Ripple has been held to less than 1 millivolt. The overall dimensions are 8¾ x 19 in. for rack mounting, with removable cover. Universal Electronics Co., 2012 S. Sepulveda Blvd., Los Angeles 25, Cal.

For more information—
Circle 126, inside back cover

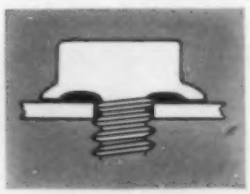
Portable Oscilloscope

A lightweight 3 in. portable oscilloscope has a new six-section unitized circuit construction for minimum interaction between amplifiers and sweeps. This permits replacement of circuit sections as individual units. Slightly larger than a telephone, the Model 385 is available as a portable, as a portable with carrying case or ready for rack mounting.

Frequency range as a vertical ampli-



New Tuff-Tite* Fastener Is Leakproof—Holds Securely —Protects Surfaces



Neoprene washer trapped under head seals hole—acts as cushion.

Tuff-Tite is a new multi-purpose fastener that gives tight, leakproof seating without cracking or chipping porcelain enamel and other fine finishes. It also dampens vibration by acting as a shock absorber and eliminating squeaks and chatter.

All this is accomplished by Tuff-Tite's one-piece metal head and assembled neoprene washer. When tightened, the neoprene is trapped and controlled by an undercut in the washer head. The neoprene is forced into the hole and around the threads to provide a cushion which protects the surface and forms a watertight and airtight seal.

Tuff-Tite fasteners are used for quick, secure, leakproof fastening of metals and plastics. They are available as tapping screws, thread cutting screws, drive screws, machine screws, stove bolts, wood screws and special fasteners. They are made of carbon, alloy and stainless steel, aluminum, brass and other metals in a variety of head styles.

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fier is dc to 4 mc, 3 db down. As a horizontal amplifier, dc to 500 kc, 3 db down. As a sweep circuit oscillator 3 cycles to 50 kc. Hickok Electrical Instrument Co., 10552 Dupont Ave., Cleveland 8, Ohio.

For more information—
Circle 127, inside back cover

Unitized Oscilloscope

This 3 in. oscilloscope is available in a rack mount. Circuit sections are available as individual units for replacement. Provision is also made for two-axis modulation.

Overall dimensions are: 19 x 5-½ x 9-¼ in. depth. Weight is 15 lb. Hickok Electrical Instrument Co., 10552 Dupont Ave., Cleveland 8, Ohio.

For more information—
Circle 128, inside back cover

Large-Screen Oscilloscopes

A series of twelve models of 17 and 21 in. oscilloscopes have a flat frequency response from dc to 10,000 cps. Down only 3 db at 100,000 cps, d-c amplifiers and inverse feedback are used to assure stability.

Specifications of both models include 5,000 v anode potential, magnetic deflection and focusing: ±1 per cent trace linearity, horizontal and vertical; a minimum of ±2 per cent measuring accuracy. Dimensions of

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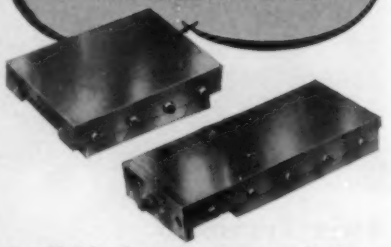
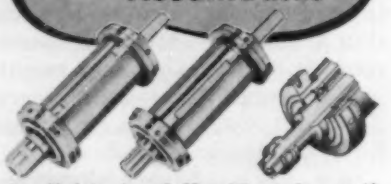


Available in 52 types and sizes. *Basic Type* includes male and female members, gib and gib screws. *Assembled Type* also has return springs, stop screw, Neoprene shield and mounting holes. Sliding surfaces furnished either *Milled* or *Hand Scraped.* Widths from 2" to 6"—lengths from 3" to 16".

STANDARD Spindle ASSEMBLIES



Available in *Collet Type* for ⅛", 3/16" and ¼" max. capacity collets; *Morse Taper Type* for No. 0 and No. 1 Morse taper shanks; and *Arbor Type* for shankless cutters with 0.375" and 0.500" center hole. *Standard Duty* has single row ball bearings at both ends; *Heavy Duty* has double row bearings at front.

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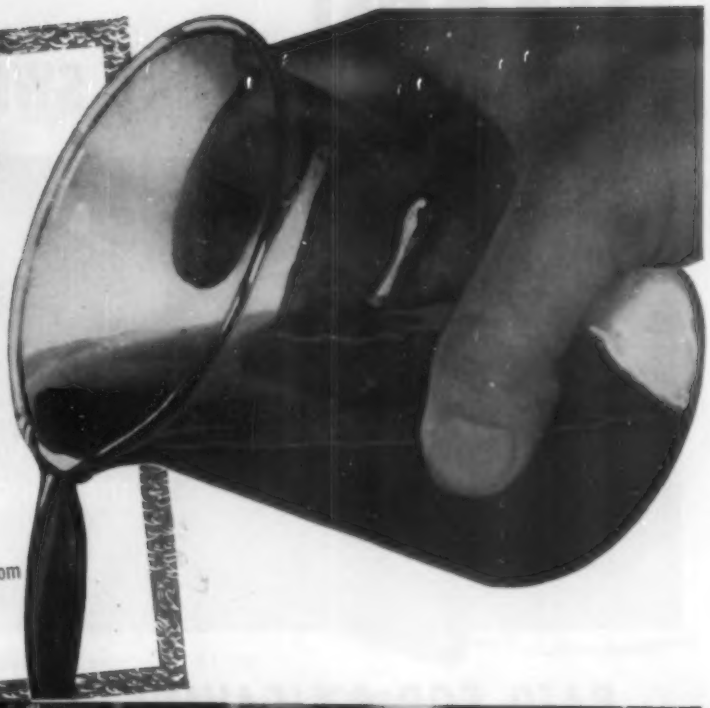

Many sealing problems encountered in equipment construction can be solved by making use of one or more of the following properties developed by elastomeric sealers based on "Thiokol" Liquid Polymer:

- Adhesion to a wide variety of metallic and non-metallic materials
- Resistance to attack by oils, solvents, water, salt spray, mild acids and alkalies
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Some of the applications using these properties are deck caulking, potting electrical connectors and sealing airplane fuel tanks. "Thiokol" Liquid Polymer was chosen as the sealer base because of its processing characteristics and physical properties. It is a fluid material that can be flowed or pressure-fed into place. On curing at room temperature it converts entirely to a resilient rubber with an unusual combination of desirable sealer properties.

Sealers based on "Thiokol" Liquid Polymer are used in many industries. They yield top performance in all applications.

Perhaps sealers of this type may help you meet a difficult processing and performance requirement. Write for technical information and samples.

Thiokol Chemical Corporation supplies "Thiokol" Liquid Polymer only as a raw material. We will gladly indicate sources of supply to end-users.

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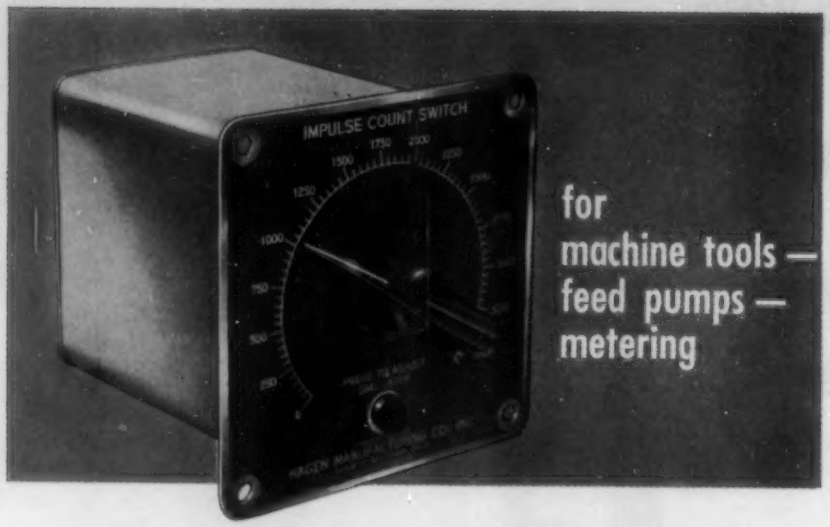
HAGEN count switch



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This Hagen Model 70 Count Switch has 72 dial divisions . . . 72 possible settings. Dials are available with up to 54,000 counts. Accuracy: 1% of full scale range. Ideal for feed pumps and metering operations. Send coupon for Bulletin 780 — or data on the complete line of reset and repeating cycle timers and counters, interrupters and control assemblies.

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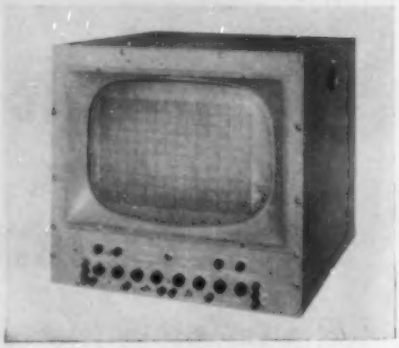


the 17 in. model without cabinet, designed for rack mounting, are 19 x 22 x 18½; of the 17 in. oscilloscope with metal cabinet, 19 x 24 x 19½ in. Technomatic Instrument Co., 11368 W. Olympic Blvd., W. Los Angeles 64, Calif.

For more information— Circle 129, inside back cover

Portable Oscillograph Recorder

This direct writing oscillograph recorder is said to provide exceptionally high stable d-c or a-c amplification. It may be used with reluctance type gauges without auxiliary equipment.

The performance specifications are 15 microvolt d-c per millimeter of pen deflection, with a response time of less than 1/120 sec. The pen excursion is over 8 cm. Offner Electronics, 5320 N. Kedzie Ave., Chicago, Ill.

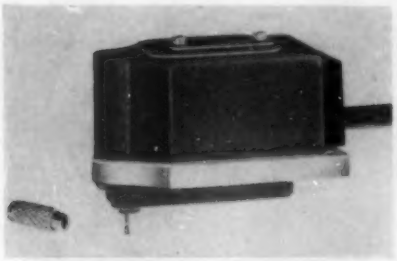
For more information— Circle 130, inside back cover

Recording Oscillograph

A writing rate of 5,000,000 in per sec and chart speeds up to 6,000 in. par sec are claimed for this oscillograph. Frequency response is 0 to

200 kc. Several different methods of recording are possible. Records may be taken on continuously-driven 6-in. or 35-mm film or paper at speeds up to 600 in. per sec or on drum-type charts at speeds up to 6,000 in. per sec. Hathaway Instrument Co., 1315 S. Clarkson St., Denver, Colo.

For more information—
Circle 131, inside back cover



Hand-Held Pickup Probes For Vibration

The probe is attached to a pivoted coil moving between permanent magnets. It transmits motion from a vibrating surface to the coil, to cause motion and a generated voltage corresponding to the motion. The signal is generally run through leads to a vibration meter, recorder, spectrum analyzer and other instruments. MB Mfg. Co., Inc., New Haven 11, Conn.

For more information—
Circle 132, inside back cover

Whiteprinter for Copies Up to 42 in. Wide

An electronic drive permits instant changes to any speed from 9 to 24 fpm in this machine, and a high-pressure, mercury vapor jacketed lamp and cooling system is said to provide uniform border-to-border print exposure. Ozalid, Johnson City. N. Y.

For more information—
Circle 133, inside back cover

Low Resistance Bridge

This self-contained, portable unit is a Wheatstone bridge with a null indicator, precision potentiometer, calibrating resistors, balanced control and battery container mounted on a panel enclosed in a box. The potentiometer has ten turns of 100 divisions each, giving a total of 1000 divisions to cover the various ohm

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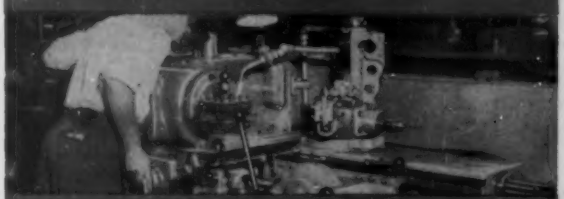

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ranges reading to 0.0001 ohm on the low range. Switching ranges are easily accomplished by a selector switch.

Built-in calibration standards with a 1/10 per cent accuracy are used for calibrating the bridge. Overall bridge accuracy is 0.25 per cent at normal requirements. Power is supplied by four "D"-size flashlight batteries. Size: $8\frac{1}{2} \times 7\frac{1}{2} \times 4\frac{1}{2}$ in. Weight: 5 lb. Kell-Strom Tool Co., Inc., Wethersfield, Conn.

For more information— Circle 134, inside back cover

Measures Machine Speeds

This device is said to be capable of measuring speeds ranging from 5 to 30,000 in per min. The synchronous-motor indicator measures at 1/100 sec intervals.

The complete $26\frac{1}{2}$ lb unit is supplied in a case measuring $9 \times 9 \times 21$ in. It operates on 110 v, 60 cps. Lake Erie Engineering Corp., Buffalo 17, N.Y.

For more information— Circle 135, inside back cover

Sealed-In-Glass Temperature Indicators

Available from stock in 38 temperature ratings ranging from 100 to 470 F, these glass tube indicators are said to provide an accuracy of ± 1 per cent. Each tube contains a strip of paper which changes irreversibly from white to black at the temperature for which it is rated. Glass vials containing the test paper is about $2\frac{3}{4}$ in. long, $\frac{7}{8}$ dia. Paper strips are available without glass tubes, in 30 ratings ranging from 115 to 490 F. Paper Thermometer Co., 10 Stagg Drive, Natick, Mass.

For more information— Circle 136, inside back cover

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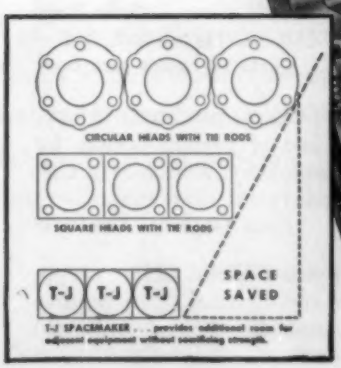
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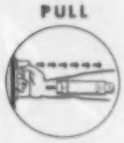

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CATALOGS and BULLETINS

To obtain copies of literature described below, circle corresponding number on postcard inside back cover.

Sealing Rings—Book, 84 pp, describes development and present facilities of this manufacturer of packings, seals and gaskets. Details of injection molding process used for rubber and plastic parts and compounds regularly in production are given. Tables of standards for components are included, as well as the ASTM methods of testing.

A table of available sizes of O-ring packings and gaskets is provided. Design suggestions for O-rings, dimensional installation data and some examples of correct and incorrect applications are contained in this section on O-rings. Cross-sectional drawings illustrate effects of varying degrees of pressure on this type of sealing member.

Similar data is provided on this company's new sealing device, a four-sided ring. This ring is said to be resistant to extrusion tendencies and spiral twisting. Information is also included on U-cups, V-rings, leather back-up washers. Minnesota Rubber & Gasket Co., 3630 Wooddale Ave., Minneapolis 16, Minn.

Circle 137, inside back cover

Dip Tank and Flowcoat Finishing—Bulletins, 8 pp, each, describe processes, discuss advantages and disadvantages of the two finishing techniques. Size and shape of dip tanks, methods of dipping, hanging of the ware, methods of agitation, tank control, as well as general suggestions and precautions are treated in the dip tank bulletin. The flowcoat brochure includes sections on limitations of flowcoating, operating variables, surface preparation, primers, topcoats, thinners. Du Pont Finishes Div., Room 7145-D, Wilmington 98, Del.

Circle 138, inside back cover

High Temperature Stainless—Data sheet, 4 pp, gives performance data on alloy A-286. Corrosion resistance and oxidation resistance data are included, along with application information, physical and mechanical properties, and heat treating information. Allegheny Ludlum Steel Corp., 2020 Oliver Building, Pittsburgh 22, Pa.

Circle 139, inside back cover

Die Castings—Standard sheets, 7 pp, cover linear dimension tolerances, parting line tolerances, moving die part tolerances, draft requirements for walls, and flatness tolerances. American Die Casting Institute, 366 Madison Ave., New York 17, N. Y.

Circle 140, inside back cover

Spring Clutches—Booklet, 20 pp, discusses basic principles and design of expanding type, contracting type, double drum, single drum, self energizing and manually or externally energized spring clutches. Marquette Metal Products Co., 1145 Galewood Drive, Cleveland 10, Ohio.

Circle 141, inside back cover

Steam Valves—Bulletin V-1, 4 pp, illustrates and describes line of bleeder, check, boiler feedwater, venturi reducing, heater bypass, balanced butterfly and atmospheric relief valves and a new high pressure, forged strainer. Schutte and Koerting Co., Dept. V-B, Cornwells Heights, Bucks County, Pa.

Circle 142, inside back cover

Relays—Bulletin, 2 pp, describes line of auxiliary relays made by Allgemeine Elektricitaets-Gesellschaft. Donald C. Seibert, Box 281, Wilmington, Del.

Circle 143, inside back cover

Cold-Finished Steel Bars—Bulletin, 54 pp, gives information on speed, efficiency, crimping, roll-threading as well as on chemistry, physical properties and available sizes. LaSalle Steel Co., 1412-150 St., Hammond, Ind.

Circle 144, inside back cover

Cooling Devices—Brochure, 8 pp, describes line of cooling devices for electronics industry. Rotron Mfg. Co., Woodstock, N. Y.

Circle 145, inside back cover

Superchargers—Bulletin 255, 6 pp, illustrates and describes rotary positive blowers used for general industrial

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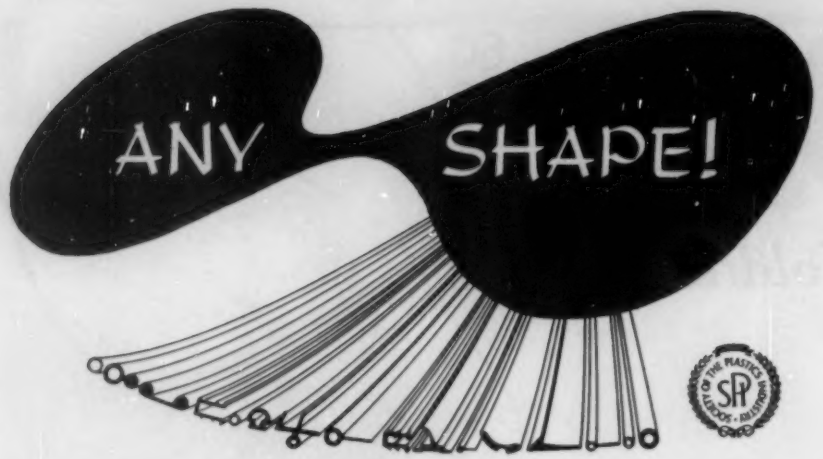

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applications, in addition to supercharging engines. Miehle-Dexter Supercharger Div., Dexter Folder Co., 100-4 St., Racine, Wis.
Circle 146, inside back cover

Rotary Air Motors—Bulletin 449, 11 pp, describes rotary air motors, compressors and vacuum pumps. Gast Mfg. Corp., Benton Harbor, Mich.
Circle 147, inside back cover

Metal Hose—Catalog 147, 12 pp, covers corrugated metal hose, convoluted hose, stainless steel hose and special purpose assemblies. Coupling data is also included . Flexonics Corp., 1351 S. 3 Ave., Maywood, Ill.
Circle 148, inside back cover

Aluminum Extrusions—Catalog, 8 pp, describes cross-sectional designs,dimensions and other details. Valley Metal Products Co., Plainwell, Mich.
Circle 149, inside back cover

A-c Motors—Catalog GEC-1026, 28 pp, presents buying information on standard a-c fractional and integral horsepower motors in most general use. Included are general-and-definite-purpose fhp motors, and fhp gear motors. General Electric Co., Schenectady 5, N. Y.
Circle 150, inside back cover

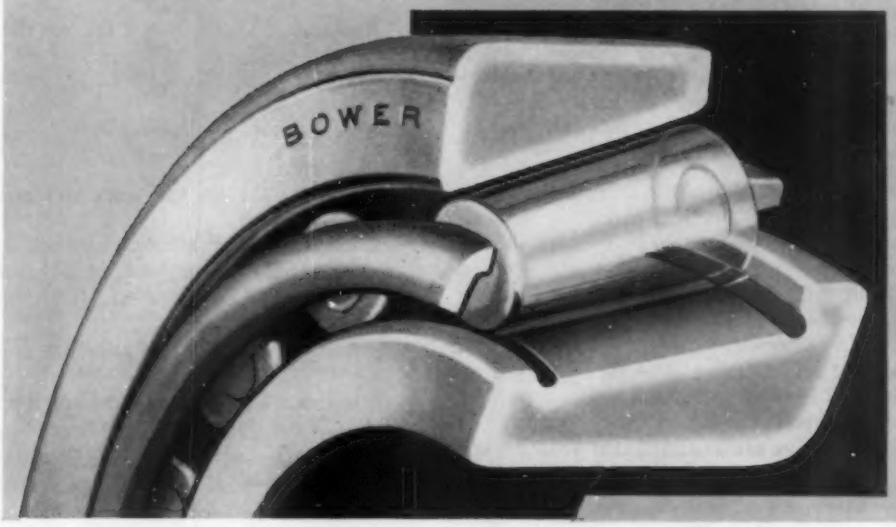
Four-Way Valve—Folder 14, 8 pp, describes a line of valves for hand, foot, cam, pilot or solenoid control of air, oil or water. Versa Products Co., Inc., 249 Scholes St., Brooklyn, N. Y.
Circle 151, inside back cover

Oscillographs—Catalog, 8 pp, discusses low and high frequency instruments and accessories. Allen B. Du Mont Laboratories, Inc., 760 Bloomfield Ave., Clifton, N. J.
Circle 152, inside back cover

Disc Resistors—Bulletin T-1, 4 pp, has data on construction, dimensions, machining technique, tolerances, resistance values, power and voltage ratings, temperature coefficient, voltage coefficient. International Resistance Co., 401 N. Broad St., Philadelphia 8, Pa.
Circle 153, inside back cover

Voltmeter Multipliers—Bulletin D-2, 2 pp, gives data on moisture-proof construction, temperature coefficient, terminations, wiring, voltage rating,

Bower spher·o·honed design provides better bearing lubrication



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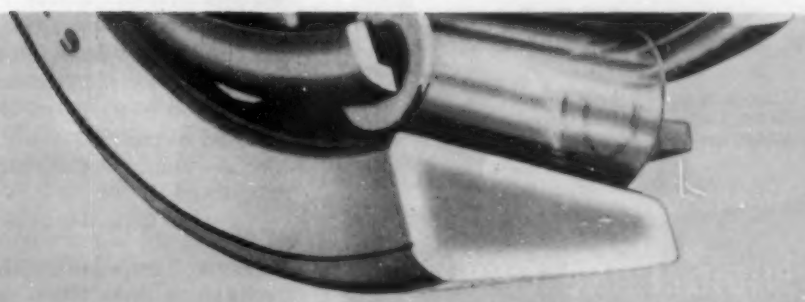

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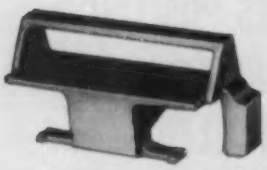

Cast brush holder for General Electric aircraft generators lowered costs, provided closer tolerances and increased strength.

Lever casting of *Atlantalloy* #31 manganese bronze with tensile strength of 100,000 psi for Sargent & Greenleaf's manipulation-proof lock.

Rugged skirt door operating mechanism cast for Pennsylvania Railroad cars manufactured by the Budd Company.

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Catalogs and Bulletins.....continued

dielectric strength. International Resistance Co., 401 N. Broad St., Philadelphia 8, Pa.

Circle 154, inside back cover

Posture Chairs–Booklet, 14 pp, describes chairs for office, drafting room and other workers. Cramer Posture Chair Co., 1205 Charlotte, Kansas City 6, Mo.

Circle 155, inside back cover

Resistors–Bulletin B-9, 2 pp, has data on characteristics, applications, tolerance, wattage rating, terminations, dimensions, insulation. International Resistance Co., 401 N. Broad St., Philadelphia 8, Pa.

Circle 156, inside back cover

Locknuts and Fasteners–Catalog, 16 pp, describes various types of locknuts. Palnut Co., 61 Cordier St., Irvington, N. J.

Circle 157, inside back cover

Aluminum Extrusions–Brochure, 4 pp, contains information on heavy extrusion presses and auxiliary equipment now being installed and gives minimum thicknesses for various alloys and circle sizes and stretch-straightening cross-section limits. Harvey Aluminum 19200 S. Western Ave., Torrence, Calif.

Circle 158, inside back cover

Tooling Resins–Brochure, 8 pp, describes epoxy resins used for aircraft, automotive and commercial tooling and foundry patterns. Furane Plastics, Inc., 4516 Brazil St., Los Angeles 39, Calif.

Circle 159, inside back cover

Vulcanized Fiber–Catalog DVF-55, 10 pp, gives technical information and various specification tables. Continental-Diamond Fibre Co., Newark, Del.

Circle 160, inside back cover

Self-Synchronous Motors–Folder EI-5A, 6 pp, covers theory of operation and also lists the design characteristics of over 30 different models. Characteristic curves, dimensional drawings and electrical data are included. Electric Indicator Co., Inc., Springdale, Conn.

Circle 161, inside back cover

Elevated Temperature Mountings–Technical Bulletin 700, 6 pp, provides data on mountings for vibration isola-

tion that are serviceable over the range from –80 F to 250 F. Lord Mfg. Co., 1635 W. 12 St., Erie, Pa.
Circle 162, inside back cover

Steam Traps–Bulletin 255, 4 pp, describes thermodynamic steam trap. Sarco Co., Inc., Dept. P, Empire State Building, New York 1, N. Y.
Circle 163, inside back cover

Stainless Steel Welding–Booklet, 24 pp, describes 17 methods employed in joining stainless steel by fusion processes. Also contains a section describing eight flame and arc cutting procedures commonly used for severing stainless steel. Crucible Steel Co. of America, Box 88, Pittsburgh 30, Pa.
Circle 164, inside back cover

Chemical Pumps–Folder, 4 pp, describes stainless steel, synthetic rubber and bronze low-volume pumps with interchangeable Teflon, Hypalon, Neoprene, carbon or Formica impellers. Eco Engineering Co., 12 New York Ave., Newark, N. J.
Circle 165, inside back cover

Plastic Structures and Pipe–Bulletin, 8 pp, describes the use of polyvinyl chloride in the fabrication of exhaust systems, process equipment and processing tanks. Also included is a section on plastic pipe and fittings. Atlas Mineral Products Co., Mertztown, Pa.
Circle 166, inside back cover

Electronic Control Equipment–Catalog B-36-A, 11 pp, gives technical information and application data on d-c amplifying unit, multi-range d-c amplifiers, sensitizing amplifiers, integrating fluxmeters, limit and knife-edge control units and product resolvers. Weston Electric Instrument Corp., 614 Frelinghuysen Ave., Newark 5, N. J.
Circle 167, inside back cover

Glass Products–Catalog 80-20, 4 pp, describes stock precision-bore glass products in quartz and glass with internal diameters controlled to within ±0.0002-in. Fischer & Porter Co., 379 Jacksonville Road, Hatboro, Pa.
Circle 168, inside back cover

Hydraulic Drives–Catalog 5310, 8 pp, includes circuit diagrams, mounting dimensions and drawings, cutaway view illustrating design and construc-

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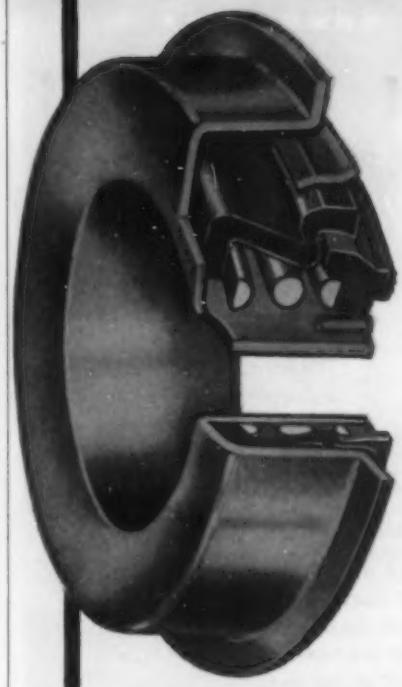

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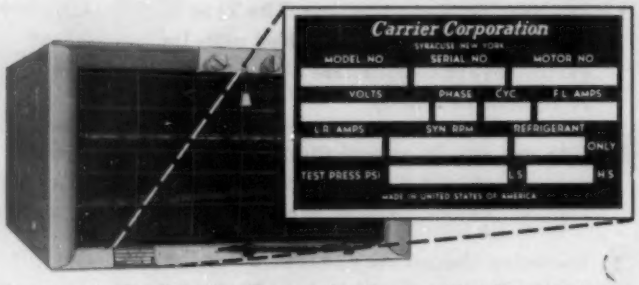

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tion details of rotating piston type of pumps, motors, transmissions. Berry Div., Oliver Iron and Steel Corp. 1018 Oliver Building, Pittsburgh 22, Pa.

Circle 169, inside back cover

Miniature Ball Bearings – House organ, 4 pp, provides technical data on design and application of precision instrument ball bearings in first issue. Will include original technical articles, charts, graphs and engineering drawings. Miniature Precision Bearings, Inc., Keene, N. H.

Circle 170, inside back cover

Hermetically Sealed Headers–Catalog 200, 16 pp, furnishes technical data on compression multi-headers of all-glass and all-metal construction. Hermetic Seal Products Co., 29-37 S. 6 St., Newark 7, N. J.

Circle 171, inside back cover

Felt Products–Brochure, 20 pp, describes uses of felt, with particular emphasis on mechanical applications. Felters Co., 210 South St., Boston 11, Mass.

Circle 172, inside back cover

Transistors–Data Sheets, 16 pp, describe line of alloy junction transistors. Transitron Electric Corp., Melrose 76, Mass.

Circle 173, inside back cover

Silicon Power Rectifiers–Data sheets, 6 pp, describe line of power supply and magnetic amplifier types. Transitron Electronic Corp., Melrose 76, Mass.

Circle 174, inside back cover

Sealed Bearings–Bulletin SF-82, 4 pp, describes line of sealed roller bearings having full length alignment of rollers at pitch circle. Roller Bearing Co. of America, Sullivan Way, W. Trenton, N. J.

Circle 175, inside back cover

Twist Prong Capacitors–Form UPK 155, 16 pp, is a comprehensive twist prong type capacitor cross-index and price list of recommended replacements for four leading brands. Cornell-Dubilier Electric Corp., S. Plainfield, N. J.

Circle 176, inside back cover

Brass Products–Booklet, 20 pp, contains weight tables, specifications and other technical data on free-cutting

brass, commercial bronze, forging rods and shapes, brass wire and boat shafting. Titan Metal Mfg. Co., Bellefonte, Pa.

Circle 177, inside back cover

Adhesives—Brochure, 16 pp, contains technical data and price information on epoxy resin adhesives. Armstrong Products Co., Dept. PE, Warsaw, Ind.

Circle 178, inside back cover

Hermetically Sealed Switch—Bulletin 1057, 20 pp, covers operation, performance and characteristics of 2½-in. long switch, which is designed to operate in any position in 1 millisecond cr less at rates as high as 400 cps. Revere Corp. of America, Wallingford, Conn.

Circle 179, inside back cover

Tachometers—Bulletin 770, 8 pp, shows types of vibrating reed tachometers. Herman H. Sticht Co., 27 Park Pl., New York, N. Y.

Circle 180, inside back cover

Heavy-Duty Contactors and Relays—Bulletin, 8 pp, describes equipment for steel mill and similar heavy industry applications, available in ratings of 25 to 100 amp, 600v. Allis-Chalmers Mfg. Co., 1002 S. 70 St., Milwaukee, Wis.

Circle 181, inside back cover

Time Totalizers—Bulletin, 8 pp, includes descriptions of each unit, time ranges, housing information, dimensions and wiring diagrams. R. W. Cramer Co., Inc., Centerbrook, Conn.

Circle 182, inside back cover

Aluminum Forgings—Booklet, 12 pp, describes press forgings, impact extrusions and hand forgings. Mechanical properties of aluminum forging alloys and typical forging applications are included. Harvey Aluminum, 19200 S. Western Ave., Torrance, Calif.

Circle 183, inside back cover

Electric Motors—Booklet, 12 pp, describes line of induction-type, ball-bearing, three-phase, 1 to 30 hp motors. U. S. Electrical Motors, Inc., Box 2058, Los Angeles 54, Calif.

Circle 184, inside back cover

Metal Wire and Ribbon—Booklet, 12 pp, describes facilities for manufacture of fine wire and ribbon, wire and ribbon parts and small parts plating.

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Catalogs and Bulletins.....continued

Sylvania Electric Products Inc., 1100 Main St., Buffalo 9, N. Y.
Circle 185, inside back cover

Fused Silica Products—Folder, 4 pp, describes tubing, shapes, fittings, containers. Amersil Co., Inc., 685 Ramsey Ave., Hillsdale 5, N. J.
Circle 186, inside back cover

Electric Conduit—Data book, 24 pp, on the use of rigid steel conduit and electrical metallic tubing. Tables are devoted to weights and dimensions, thread and coupling dimensions, standard radius elbows, special radius conduit elbows and nipples for rigid steel conduit. Similar tables are given for electrical metalic tubing. Pittsburgh Standard Conduit Co., 61 Bridge St., Pittsburgh 23, Pa.
Circle 187, inside back cover

Shaper Systems—Bulletins describe line of shaper units and control devices for vibration testing installations. Calidyne Co., Winchester, Mass.
Circle 188, inside back cover

Reducing Camera—Booklet, 8 pp, gives operating instructions and specifications, including clearances required, for this camera and the continuous processing unit designed for use with it. Peerless Photo Products, Inc., Shoreham, N. Y.
Circle 189, inside back cover

Temperature Control Systems—Bulletin, 8 pp, contains explanation of the various types of control systems, ranging from two-position "on-off" to proportional position with automatic reset. Barber-Colman Co., Rockford, Ill.
Circle 190, inside back cover

Drafting Room Furniture—Catalog 554, illustrates, describes and gives specifications for files, tables, sectional steel filing cabinets, drafting tables and accessories. Stacor Equipment Co., 768-778 E. New York Ave., Brooklyn 3, N. Y.
Circle 191, inside back cover

NEMA Standards—Bulletin 1600A, 7 pp, compares old and new frame sizes and dimensions for 1 to 40 hp induction motors. Louis Allis Co., Milwaukee 7, Wis.
Circle 192, inside back cover

Leaded Steel—Bulletin 14-6, 4 pp, describes 0.50 carbon alloy. Joseph

T. Ryerson & Son, Inc., Box 8000-A, Chicago 80, Ill.
Circle 193, inside back cover

Control Components–Bulletin 355, 4 pp, gives specifications and characteristics of 130 synchros, servo motors and various resolvers. Norden-Ketay Corporation, 555 Broadway, New York 12, N. Y.
Circle 194, inside back cover

Rotary Gear Pumps–Booklet, 26 pp, describes pumps for liquids having lubricating properties. John S. Barnes Corp., 301 S. Water St., Rockford, Ill.
Circle 195, inside back cover

Relays–Bulletin 108, 2 pp, lists sensitive relays and plug-in assemblies for automatic control circuits. Assembly Products, Inc., Chesterland, Ohio.
Circle 196, inside back cover

Printed Circuitry–Booklet, 8 pp, describes application, uses and advantages of printed circuits in various electrical products and equipment, as well as technical information to aid in design or planning of printed circurity. Cornell-Dubilier Electric Corp., S. Plainfield, N. J.
Circle 197, inside back cover

Resistors–Bulletin SR-3, 6 pp, contains data on applications, characteristics, current ratings, enclosures, terminations. International Resistance Co., 401 N. Broad St., Philadalphia 8, Pennsylvania.
Circle 198, inside back cover

Letterhead Requests Only

Manufacturers who published following literature ask that requests for copies be made on company letterheads.

Germanium Diodes–Bulletin GD-2, 4 pp. describes germanium point contact diode line. An interchangeability and replacement chart is also included. International Rectifier Corporation, 1521 East Grand Avenue, El Segundo, California.

Miniature Motors and Fans–Bulletin 254A, 38 pp, contains specifications and descriptions of more than 50 miniature motors, fans and blowers. Western Gear, P. O. Box 182, Lynwood, California.

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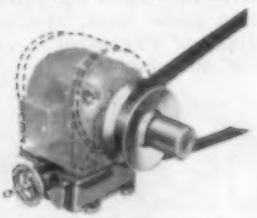

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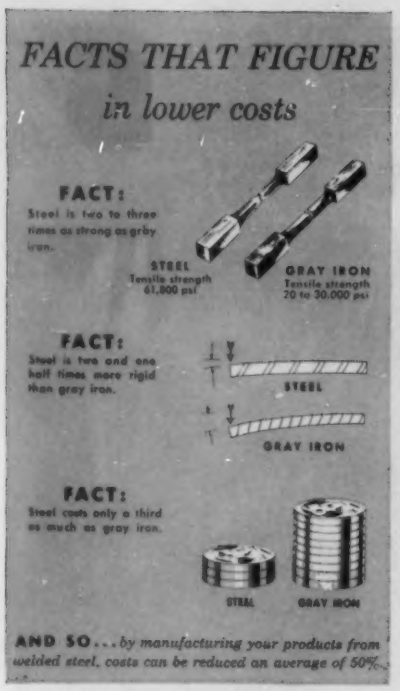
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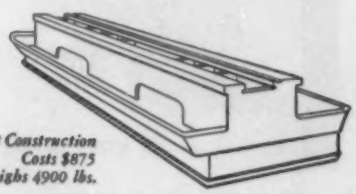

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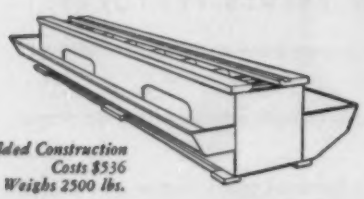

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Ad Libbing by the Editor

Big Frank was a business man of the old school. He also had a candor about him that some times was almost shocking. His ability to strip a problem of all of its dressings and present it as just bare facts was often disconcerting to the men with whom he dealt.

One day I was driving Big Frank over to the railroad repair shop where he was having a job done. It was a twenty mile drive so we had plenty of time to chat. In the course of our conversation I brought up the subject of labor discontent. No sooner had I posed the problem than Big Frank took over and presented all phases of the problem from a to z, as he saw it. I cannot recollect the conversation sufficiently accurately to be able to quote Big Frank word for word, but this is the gist of what he said.

If a business is to continue as a business rather than a charity organization, it is necessary that each employee shall earn for the business more money than the business pays him. This applies to everyone from the president down to the floor sweeper. The difference between what the employee gives and what he gets pays the rent, insurance, plus all other overhead. What is left over is profit.

If an employee of the business is paid more than he earns for the business it means not only that the individual is getting more than he is entitled to but also that somebody must foot the bill. Either the other employees do part of the job of the man who is being overpaid or the loss is deducted from profits.

If a company is careless and pays many of its men more than they are worth, then it must be true that about an equal number of men are being paid less than what they are worth or the company is going bankrupt.

Expanding upon his business concepts, Big Frank went on to explain that the company is to blame, and seriously so, if it pays men more money than those men can earn for the company. In doing so the company is allowing a situation that is a serious injustice to the other employees and to the stock holders. In this respect, every company has a two-fold responsibility. First, the company must put each man in a job where he is able to earn more than what the company is paying him. Secondly, it is the responsibility of the company to train the men so that when they are promoted they will be able to take over their increased responsibilities and continue to earn for the company more money than they receive from the company.

Following this, Big Frank gave a number of examples wherein the employer paid his men more than they earned for the business and therefore the business, being small, soon went bankrupt. Only a large corporation can afford the loss incurred in keeping men on the payroll who are not worth their salt. The solution is either to train the man to make him worthy of his hire, to transfer him to a position where he will be worth his pay or, as a last resort, if he is a round peg in a square hole he should be advised to seek a new connection.

Sometimes a man in middle age

American Quality Felt

...makes sweet music

Pianos contain American Quality Felt in various types to assure good tone, instant action and acoustical correction. Piano felts are most exacting, and American leads in this field. No wonder industrial users find that American felts make sweet music for them, protecting the performance and reputation of the machines that use them for lubrication, sealing, vibration control, filtration, honing, weatherstripping, insulation. It is important to select the right type of felt; American engineers will collaborate with you on specific applications.

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finds himself unable to hold his job. This may be because the boss was mistakenly generous to him or did not have the courage to be frank and honest in telling the man his shortcomings. Or sometimes a man cunningly succeeds in fooling his employer by bluffing. Sometimes an executive thinks he is lucky because he has a brilliant subordinate who quietly and unobstrusively carries many of his responsibilities. But when this loyal subordinate is promoted, transferred or taken off the job for other reasons, this boss finds himself completely at a loss. The final results of any of these situations are piteous to behold. At middle age the individual may find himself unable to carry on in his job. He has a dismal future and it requires almost a miracle to save him.

Now let us take a look at bosses.

Authority carries with it grave responsibilities. Fortunately, most of the men who achieve a position of greatness are men of character and dignity and are altruistic. And it is fortunate that when an individual who has a super abundance of greed, selfishness and acquisitiveness reaches a position of power and trust, these highly undesirable characteristics usually gang up against him and often cause his downfall.

The man who concentrates to much on his selfish objectives generally fails to recognize the more important constructive problems that are demanding his decisions.

The power that goes with authority does not in any way relieve the man of the responsibility of being constructive in his relationships with all the men in his organization, especially his subordinates, nor does it relieve him of being responsible for his decisions.

Big Frank was a tough man to work for. Often he aroused a great deal of anger in the men who worked for him. But he was ever mindful of their welfare. He always did everything possible to develop them. His often brutal frankness was Big Frank's own special way of giving advice to his men or straightening out any signs of waywardness that they might show. One could criticize many of Big Frank's characteristics but nearly everyone agreed that he was more than fair in the treatment of his men and often he came to their help in their personal or financial problems. —G.F.N.

ENGINEERING ABSTRACTS

Survey of Non-Contacting Vibration Pickups Using Electric Fields

Abstracted from "A Survey of Non-Contacting Vibration Pickups Using Electric Fields," by H. F. Clarke, Boeing Airplane Co., Seattle, Wash.; presented at the AIEE Winter General Meeting, New York, N. Y., Jan. 31-Feb. 4, 1955.

In the transducer systems discussed in this paper, no mechanical connection is made to the vibrating body; the vibrating displacement being sensed by its effect on an electric field between the vibration pickup and the object under test.

In the non-contacting transducer system, there are no moving parts except the object being shaken, thereby eliminating pickup resonances of unwanted modes of vibration. Another advantage is that the pickup does not mechanically load the vibrating body. The system may be arranged to have negligible side-sensitivity, and to have almost no practical limit to its frequency response from zero frequency upwards. This means that these devices are especially well adapted to use as transfer devices between static and dynamic displacements, as they may be calibrated statically.

A disadvantage of electric-field systems is the fact that their sensing field cannot be confined to a small area without also confining their linear range. A second disadvantage is that the vibrating surface must usually have some known geometry, such as flat sheet. Also, the nature of the material of the vibrating surface is critical, these systems being chiefly for surfaces of nonferromagnetic materials of high conductivity.

A disadvantage of capacitive vibration pickups is the difficulty of obtaining sensitivity and linearity with small probe size. In the capacity-type pickup, the capacity of the sensing element itself is often no greater than the leads connecting it to a following circuit. Since the capacity of these leads is in parallel with the capacity of the sensing element, the effective percentage change in the sensing element ca-

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In assembling units equipped with Bunting Bronze Bearings there is no bearing to be pressed against a shaft shoulder no lock nut nor washer to hold the bearing and no outside end cover or enclosure.

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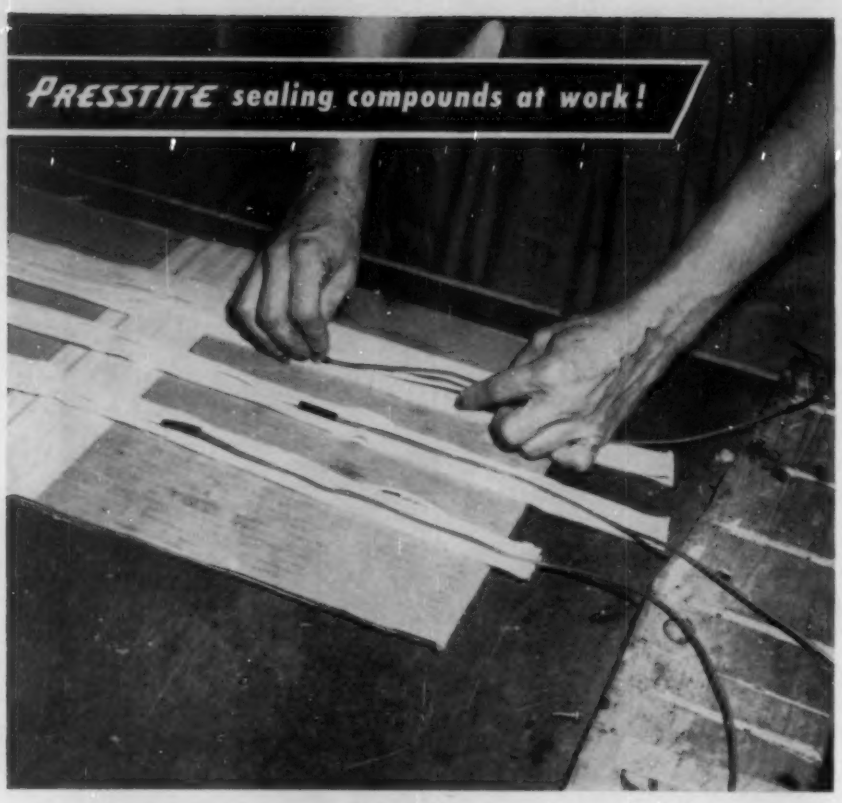

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pacitance, as seen by the circuit, becomes smaller as the leads grow larger.

The frequency response of the ordinary condenser microphone will not extend down to d-c because of the use of d-c excitation through a shunt resistor, and such a device will not serve as a transfer between static and vibratory displacements. For static to dynamic displacements, a carrier system must be used. The capacity probe can be used to vary the frequency of an FM system, but here again problems of linearity may be encountered. For stability and noise level, the capacity probe appears comparable with other systems and it is not disturbed by ferromagnetic material in the target.

Microwave systems are somewhat related to the capacity-type pickup, in which a carrier frequency is used. With high frequencies, a change in a very small capacitance appears as an appreciable susceptance change and if this is applied at the termination of a transmission line, the resulting change in reflection coefficient of the termination, as seen at the input terminals of the line, is not appreciably diminished by increasing the length of the line. This comparatively large change in reactance or susceptance is propagated down a transmission line without serious loss.

Microwave systems have the advantage that a small geometry change at very high frequencies can effect a large reactance change. They are usable on nonconductors which will give appreciable reflections from their surfaces, and will work on magnetic material. The probe size required at present is comparable to other systems, but there seems a possibility that very small probes might be made with a larger linear region, in relationship to probe size, than with the other systems discussed. One variety may be made with standard components available in any radar laboratory. Their chief drawback is bulkiness and low output level, and they are probably less stable than other systems.

Mutual inductance systems are probably the most developed and perfected of any of the methods. They have been engineered for convenience and ease of use, and have moderately small probes on the ends of cables to the indicating equipment, thus eliminating bulky pickups being placed near the vibrating object. They give high

output voltages for small displacements. They cannot be used on nonconducting materials. The National Bureau of Standards system has an established calibrating procedure, permitting direct reading in inches, end to end of the vibration, and it also has a series of filters for examination of small high frequency vibrations in the presence of comparatively large low frequency building and apparatus vibrations.

Reinforced Plastics and Other Related Materials

Abstracted from "Reinforced Plastics and Other Related Materials," by T. J. Scheirer, Ch. Chemist, Winner Mfg. Co., Inc.; presented at the 11th Annual National Technical Conference, Society of Plastics Engineers, Inc., Atlantic City, N. J., January 1955.

The molding resins most generally used in reinforced plastic production are polyesters, epoxies and phenolics. These are used in conjunction with catalysts and curing systems as they may be needed to produce a specific part. Other resinous materials used are silicones, alkyd-diisocyanate formulations, melamines, furfural and sheet of styrene modified copolymer.

The selection and use of fillers with thermosetting resins is important from the standpoint of controlling physical and handling characteristics and they may be classified under two basic categories; reinforcing and bulking. The reinforcing materials include glass monofilaments, glass mats, woven fabrics and rovings.

Cellulosic materials do not have the same strength as glass but they are used to improve the abrasion resistance of a laminated item. Some of the more popular fibers used in this category are those of cotton, sisal, jute and hemp. Synthetic resin fibers are now coming into use and some of them may become important as filler or bulking materials.

A number of new fillers are being used for bulking polyester and epoxy resins. These are used to induce particular characteristics in the molding and casting resins or in the ultimately cured mass; such as resin flow, over-all density, shrinkage control, surface appearance, color, strength and economies. A few of these fillers are silicone dioxides, silicates of aluminum, calcium, and magnesium; cal-

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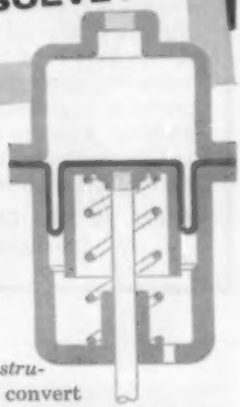

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Ney manufactures many other precious metal alloys which, like Paliney #7, have ideal electrical characteristics, high resistance to tarnish, and are unaffected by most industrial atmospheres. Ney Precious Metal Alloys have been fabricated into slip rings, wipers, brushes, commutator segments, contacts, and intricate component parts and are used in high precision instruments throughout industry. Should you have a contact problem, a call to the Ney Engineering Department will result in study and recommendations which will improve the output of your electrical or electronic instruments.

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cium carbonate either as a precipitated chemical or ground rock and oyster shells ;clay, expanded minerals; such as mica and volcanic ash, and ground or disintegrated metals. The carbonates are probably most widely used because of low cost and high loading.

True pigments are classified as fillers although their main function is to impart color to the item. These are available as readily dispersed dry colors or as pigment concentrates where a high concentration of dry color is ground into a suitable vehicle, usually a slow-drying alkyd or a polyester. Caution must be used in selecting color, for certain yellows, reds and blacks will increase time for complete cure.

Computer Analysis of Industrial Control Regulating Systems

Abstracted from "Computer Analysis of Industrial Control Regulating Systems," by W. W. Bolander and J. T. Bradford, Jr., Industry Control Engineering Dept., General Electric Co., Schenectady, N. Y.; presented at AIEE Winter General Meeting, Jan. 31-Feb. 4, 1955, New York, N. Y.

Technological advances in industrial processes have created difficult problems for the designer of industrial control equipment. Design of regulating systems has become more exacting because of the need of higher system gains and more effective control of the transient response of the regulating system. The extrapolation of data from past designs to today's problems is quite uncertain and in some applications impossible. Determination of system response behavior by classical means is inaccurate, time-consuming and impractical. A means of aiding the designer is use of an assimilator.

There are two types of computers available—analog and digital. The analog computer is best adapted for the solution of system regulating problems. It is preferred over the digital computer since system-analysis information can be more easily introduced into an analog computer. Also, accuracy requirements for solving a problem do not justify the expense.

Due to the efforts of the computer manufacturers, the operation of an electronic analog computer is straightforward. The heart of the computer is very high gain stabilized d-c amplifiers. By connecting suitable circuits a

desired mathematical representation can be obtained.

A regulating-system problem may be solved on a computer in either of two ways. First, the problem may be expressed as a number of simultaneous differential equations; and the computer solves these equations directly. Second, the computer may represent the transfer function of individual physical components in the system. The computer representations of the physical components can then be combined to assimilate the entire system.

The approach normally taken for analyzing systems is to break the system down to individual components such as motors, generators, amplifiers, tachometers. The next step establishes transfer functions and computer representations for each of these individual components. Many of the components used in the analysis are repetitive and the transfer functions and computer representations for these components can be tabulated. The regulating system is then established on the computer by interconnecting the individual representations.

Advantages of this approach are: First, the identity of all physical quantities (such as speed, amplifier output) may be easily retained on the computer. Second, by tabulating representations for the individual components in the system, considerable time is saved in setting up the problem.

The computer components are now varied in such a manner as to simulate system operation or variation of system parameters in order to obtain results outlined in problem definition.

In the design of standard regulating systems the computer is useful in establishing circuit and design details of the regulating system. After the system has been established, it can be used to determine the range of application of the system.

Many applications occur where it is not possible to use standard regulating systems. Here the computer is used to aid in designing a new system. By effective use of the computer, it is possible to obtain the most economical and effective assembly of equipment to give the best performance.

An important advantage of using the computer is in simplifying the installation of equipment. By simulating the entire system on the computer, the equipment may be effectively preadjusted to reduce installation time.

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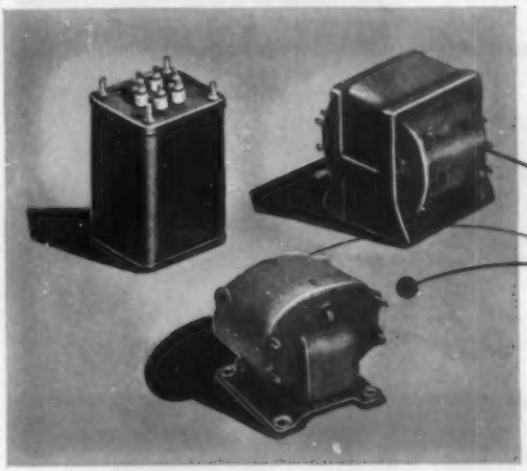

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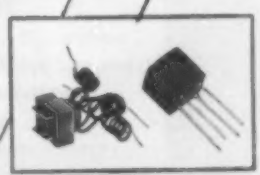

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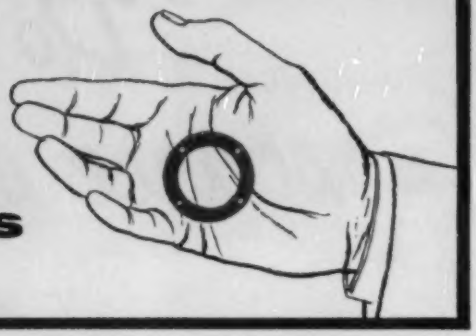

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NEW BOOKS

Alternating-Current and Transient Circuit Analysis

HARRIS A. THOMPSON, *Associate Professor of Electrical Engineering, University of Colorado, Chief Engineer, J. J. Monaghan Co., Denver.* 9¼ x 6¼ *in., 320 pp. Published by the McGraw-Hill Book Co., Inc., 330 W. 42 St., New York 36, N. Y., $6.75.*

A new book in the McGraw-Hill electrical and electronic engineering series, this text is a modern introduction to the fundamental concepts of practical steady-state a-c circuit analysis and transient analysis. While the book is intended primarily for first courses in the subject for electrical engineering students, it is an excellent reference for the busy engineer who has occasion to review such material.

The essentials of circuit analysis are presented in an efficient manner which permits ready application of these analysis techniques. Transient analysis is developed from traditional methods with emphasis on the applications and understanding of the basic behavior of electrical circuit parameters.

The sequence of presentation logically develops the use of complex numbers and phasors as a tool for analysis problems using complex algebra. Also included are chapters on special aids in circuit analysis, three-phase circuit analysis, nonsinusoidal periodic waves, and mathematical analogs using electrical circuit elements.

Higher Transcendental Functions, Vol. III

Sponsored by the California Institute of Technology and compiled by the Bateman Project staff under the direction of A. ERDELYI, *Prof. of Mathematics,* 9¼ x 6¼ *in., 312 pp. Published by the McGraw-Hill Book Co., Inc., 330 W. 42 St., New York 36, N. Y. $6.50.*

This is the final volume of the three-volume work of reference on advanced mathematics. The three books together provide an extensive

compilation of all the "special functions"—solutions of a wide class of mathematically and physically relevant functional equations—found to be most useful in pure and applied mathematics. There are no other tables of a similar scope or on a similar scale. These books provide all the information commonly needed on special functions, such as properties, interrelations, representations in various forms, micro- and macroscopic behavior and tabulations of same, and inclusion of tables of formulas relating to the functions treated.

This volume contains material on automorphic functions including elliptic modular functions, Lame, Lame-Wangerin, Mathieu functions, spheroidal and ellipsoidal wave functions, functions occuring in number theory, and some miscellaneous functions such as Mittag-Leffler's. There is also a chapter on generating functions together with a list of the known ones.

Small-Scale Inorganic Qualitative Analysis

J. T. Stock, *M.Sc., Ph.D., F.R.I.C., Head of Dept. of Chemistry and Biology, Norwood Technical College, London, and* P. Heath, *B.Sc., A.R.I.C., Asst. Lecturer in Chemistry, Norwood Technical College, London.* 4¾ x 7½ *in., 96 pp. Published by Chemical Publishing Co., Inc., 212 Fifth Ave., New York, N. Y.* $2.50.

This book describes the equipment and techniques required for small-scale operations in identifying the more usual acidic and basic radicals. A small-scale operation in analytical practice saves time and labor provided that the results are reliable. Normally, a small-scale operation should be simpler and more reliable than the usual macro procedure.

The book is not written for the design engineer but chemists and physicists should find it useful.

Supplements to ASTM Standards

These 1954 supplements, in seven parts, give in the latest form 415 specifications, tests and definitions issued for the first time in 1954 or revised since appearing in the 1952 or 1953 supplements. The new vol-

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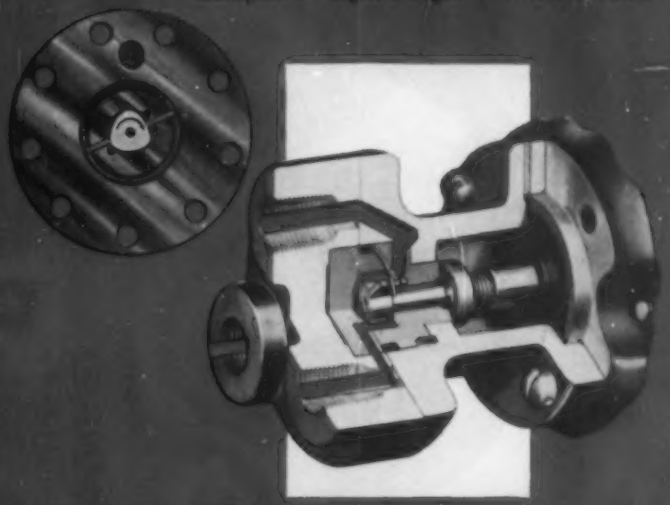

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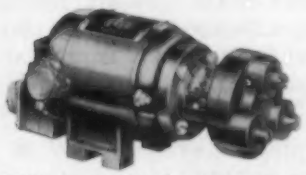
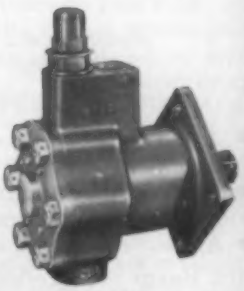


STYLE A—Single inlet double outlet type aircraft pump



STYLE F—Engine driven fuel pump

STYLE C—Industrial pump

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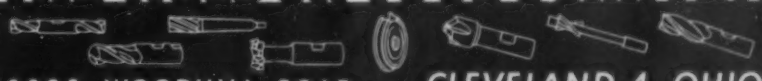

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Part 6: Rubber, Plastics, Electrical Insulation—532 pp

Part 7: Textiles, Soap, Water, Paper, Adhesives, Shipping Containers—296 pp.

Fluid Mechanics

R. C. BINDER, *Ph.D., Prof. of Mechanical Engineering, Purdue University.* 6 x 9 in., 388 pp. *Published by Prentice-Hall, Inc., 70 Fifth Ave., New York 11, N. Y.* $7.65.

Intended as an introduction to the fundamentals of fluid mechanics, this third edition is divided into two parts, the first of which deals with basic relations that exist in any case of flow, such as: statics, kinematics and dynamics of fluids, the energy equations for steady flow, dimensional analysis and dynamic similarities. The second part presents applications in fluid mechanics in self-contained chapters that show how the basic relations are applied and give information about special cases and current practice. Included are analyses of turbines and torque converters, control systems, and lubrication in journal and Kingsbury bearings.

Patent Fundamentals For Engineers

HENRY K. LEONARD, *Patent Attorney,* 5¾ x 8¾ *in.* 39 *pp. Published by Pelex Publishers, 95 Liberty St., New York 6, N. Y.* $2.

In this concise little spiral-bound book the author covers briefly what patents are, how they work and what a patent lawyer thinks engineers should do with patents. Because it

is written in nonlegal and concise style it is fast reading and understandable, almost conversational in tone. The first chapter, on "Obtaining A Patent", includes a discussion of the requirements as modified by recent legislation (see PRODUCT ENGINEERING, March, 1955, pp. 193); requirements for novelty and utility are defined as well as the meanings behind conception, diligence and interference.

The second chapter discusses the parts of a patent and their purposes in a concise and straightforward way. The significance of utility as a patent term is also thoroughly discussed. The final chapter discusses the rights of employed inventors and employment contracts, perhaps too briefly.

Pocket Book of Chemical Technology

V. STANNETT, *Ph.D., State University of New York, College of Forestry, and* L. MITLIN, *M.A., Imperial College of Science and Technology,* 4¼ x 7 *in., 283 pp. Published by the Chemical Publishing Co., Inc., 212 Fifth Ave., New York, N. Y.* $4.75.

Both chemical and chemical engineering data are included in this handy volume. It was apparently written to present the information most generally used by engineers in a small book for time saving purposes.

Details of radioactive isotopes and labeled compounds are included in a chapter on radioactive materials. A glossary of chemical and chemical engineering terms as well as a detailed index are additional features of the book. This book should prove useful to those technicians who require quick and ready reference material.

Conversion Factors and Tables

O. T. ZIMMERMAN, *Ph.D., Prof. of Chemical Engrg., and Chairman of the Dept., University of New Hampshire, and* IRVIN LAVINE, *Ph.D., Prof. of Chemical Engrg., University of New Hampshire.* 4½ x 6½ *in., 501 pp. Published by Industrial Research Service, Inc., Masonic Bldg., Dover, N. H.* $5.

This book contains conversion factors and tables for weights and meas-

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ures, volume, temperature, thermocouples, pressures, specific gravity, viscosity, hardness, wire and sheet metal gages, decimal equivalents. In addition, common five-place logarithms are provided. In many cases, where weights and measures, volume and other similar types of values are given, tables are provided making it possible to convert a factor from the terms of measurement used in one country to those of many others.

Automotive Fuel, Lubricating And Cooling Systems

WILLIAM H. CROUSE, *Member, SAE and ASEE.* 6 x 9 in., 421 pp. *Published by the McGraw-Hill Book Co., Inc., 330 W. 42 St., New York 36, N. Y.* $5.75.

This is one of a series of five books covering in detail the construction, operation and maintenance of automobiles. The treatment throughout is aimed at providing information essential to an automotive mechanic.

This particular volume discusses lubricating, cooling and fuel systems and components. The section on fuel systems covers the LPG type as well as the conventional gasoline systems.

The Strain Gage Primer

C. C. PERRY, *Asst. Prof. of Engineering Mechanics, Wayne University and Research Consultant, and* H. R. LISSNER, *Prof. and Chairman, Dept. of Engineering Mechanics, Wayne University.* 6 x 9 in., 281 pp. *Published by the McGraw-Hill Book Co., Inc., 330 W. 42 St., New York 36, N. Y.* $6.

This is a very practical introduction to strain gage technique aimed directly at the user. The various methods of strain measurement are discussed, including optical strain measurement, brittle lacquers, and electric strain measurement.

Bonded wire resistance strain gages are given the most extensive treatment. Their appearance, composition, manufacture, operation are described.

Strain gages are deceptively simple in operation and engineers inexperienced in their use will often place them incorrectly or misinterpret the resulting data. Here are described

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A SPECIAL REPORT ON PROTECTIVE FINISHES FOR ALUMINUM

Most aluminum producers and fabricators are well aware of the superiority of chemical finishes over anodizing for the protection of aluminum from corrosion. Naturally, then, there is a running battle for acceptance among the leading producers of the protective chemical finishes.

That's why, here at Allied, we have always studied your needs with regard to both our own and competitive processes. We're constantly trying to produce new and better finishes because we believe there's always room for improvement . . . even to our own products. Some years ago this policy led to the introduction of a process, long in development, that offered you a way to overcome anodizing's obvious technical complications . . . Iridite #14. This finish was far easier to use than anodizing, yet provided comparable, if not superior, quality. And, its cost was much less than anodizing.

But other finishes offering similar advantages over anodizing have entered the market. So . . . the current battle for acceptance. By any cost comparison Iridite #14 is the most economical. However, corrosion tests by users show contradictory results as to performance from Iridite #14 and other leading protective finishes for aluminum. Most tests show Iridite #14 superior, but some do not. The margin of difference, however, is always small. The truth is that all have proved good. However, our laboratory research indicated that still further improvements could be made.

That knowledge . . . plus our aim to give you even better protection and maintain the leadership of the industry, is exactly why Allied Development Engineers have been working for long years to develop a better finish than any of those now available, including our own Iridite #14.

Now the new finish is ready for you. It's called Iridite #14-2 (Al-Coat).

From a performance standpoint, Iridite #14-2 gives you two important advantages in the protective finishing of aluminum.

FIRST: in its fully colored brown film stage it provides corrosion resistance decidedly superior to previous processes.

SECOND: the basic brown film can be hot water bleached to produce a clear-type film with protection heretofore unobtainable from clear-type chemical finishes.

From an operating standpoint, new Iridite #14-2 gives you three important advantages.

FIRST: it provides consistently higher corrosion resistance for different aluminum alloys treated in the same bath.

SECOND: it provides a more uniform appearance for parts of different alloys and with varied surface finishes before treatment.

THIRD: its operating and technical characteristics are superior to those of other processes.

If you are using or planning to use a chemical finish for aluminum, you should have full details on new Iridite #14-2. Write us or send samples for free test processing. Or, for more immediate advice, call your Iridite Field Engineer. He's listed under "Plating Supplies" in your classified telephone book. - - - ALLIED RESEARCH PRODUCTS, INC., 4004-06 EAST MONUMENT STREET, BALTIMORE 5, MARYLAND.

P. S. Even new Iridite #14-2 will be constantly measured against both your needs and competitive processes to make sure you get the best possible, most economical finish for your product that man and the laboratory can develop.

cementing it in place properly oriented, associated instrumentation, and the interpretation of results. Since strain measurements are often required on rotating members, a chapter is included on slip rings and switch contacts in strain gage circuits.

Some special applications of strain gages as transducers provide an introduction to possible uses far beyond that of simple strain measurement.

Principles of Machine Design

S. J. BERARD, *Prof. of Mechanical Engineering, Emeritus, Brown University;* E. O. WATERS, *Strathcona Prof. of Mechanical Engineering, Yale University;* and C. W. PHELPS, *Asst. Prof. of Mechanical Engineering, Yale University.* 6¼ x 9¼ *in.*, 534 *pp. Published by The Ronald Press Co., 15 E. 26 St., New York 10, N. Y.* $7.50.

In scope and content, this book has been planned for a one-year engineering course to follow kinematics and strength of materials. Throughout, its aim is to develop rational and consistent methods of design, as applied to the more common elements of machine construction.

The arrangement of subject matter is logical and one that should be easy to follow. Part I is devoted to fundamentals, to engineering materials, and to the principles of theoretical design. In Part II, on fasteners and fastening methods, emphasis is given to the Unified and American Standard for screw threads as an excellent example of cooperative standardization and particular attention is given to welding because of its influence in the field of design and construction.

Parts III and IV are devoted to power transmission equipment. The discussion of overrunning clutches and hydraulic drives includes a simple application of dimensional analysis, which is also employed in a succeeding chapter on sliding-bearing design. Here the authors introduce the recent method of rating ball bearings.

Part IV, on gearing, is more fully developed than is customary in machine-design textbooks. Chapter 12 introduces the new method of rating the horsepower capacity of V-belts, and includes toothed-belt timing drives. Part V covers springs, brakes, curved beams, other mechanisms and elements, and hydraulic controls.

Photo courtesy Martin Aircraft

Martin Jet Bomber B-57B—package of engineering ingenuity wields new speed and mobility in this

★ Modern Arm of the Air Force ★

Wrapped up in this modern arm of the skyways is the wizardry of Martin engineers—masterminds who gave this fighting bomber a supremacy of visibility, mobility, speed and control.

In the success of this fighting craft, Continental takes modest pride in being selected to engineer and supply many of the molded and extruded rubber parts. A typical example is the cockpit seal which must not craze plexiglass and yet must remain flexible *even* at −70°!

Compounding and extruding rubber that will not craze plexiglass is a problem in itself. Producing rubber to remain flexible at −70° is still another. Furthermore, this part must have an exceptionally low compression set in order to retain its perfect seal. Resistance to every weather condition is *also* a must.

Producing a rubber part to meet all these critical specifications was a real challenge! Proper plasticizers had to be chosen, extensive laboratory tests conducted, and special handling was necessary to maintain the extremely close tolerances required. A challenge that Continental met and exceeded because of their 50 years' skill and experience in the specialized art of molding and extruding rubber.

The technical assistance offered for this part typifies the service available at Continental. When you need "engineered rubber parts," enlist the service of specialists—consult Continental.

Engineering catalog.

In addition to custom-made parts, Continental offers an extensive line of standard grommets, bushings, bumpers, rings and extruded shapes. Hundreds of these are shown in the No. 100 Engineering Catalog. Send for a copy or refer to it in Sweet's Catalog for Product Designers.

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OUR READERS SAY . . . . . .

Letters should be addressed to the Editor, *Product Engineering*, 330 W. 42 St., New York 36, N. Y.

Patent Office Situation

To the Editor:

I was very pleased to see the article on the Patent Office situation in the April, 1955, *Product Engineering*. I feel that the more industry's attention is called to this deplorable situation, the sooner conditions will be improved. Your article does a very excellent job in pointing out the need for more examiners. However, there is no mention made with regard to one of the reasons for the Patent Office being in their present critical financial stiuation. What has actually happened is that while the work has been increasing, the appropriations for the Patent Office have actually decreased. I have enclosed a leaflet prepared by the New York Patent Law Assn. which points up the fact that the money spent by the Patent Office in 1954 is less than that spent in either 1953 or 1952. This reduction in expenditures has, of course, been forced by a reduction in appropriations despite a rising work load. If your readers' attention could be called to this situation editorially with a plea that they urge their congressmen to support an increase in the appropriation for the Patent Office, I am sure this would help.

—Frederick E. Lange,
President
Minnesota Patent Law Assn.

Ed—The leaflet enclosed with Mr. Lange's letter was of considerable interest and we expect to use some of the information it contained in a follow-up article later this year.

What Makes An Engineer?

To the Editor:

May I say that I, too, am in opposition to the current idea that each engineering student be compelled to

take a bachelors degree in a liberal arts college before he is allowed to continue his studies in engineering. I am in accord with Dr. Rogers of Polytechnic Institute of Brooklyn and with your editorial, "An Engineer Speaks Out," in the April, 1955, *Product Engineering*. I note of late increasing propaganda to the effect that all engineers should first be compelled to go to liberal arts colleges, and I can see no justification for this idea. It has been my experience that the average engineering graduate is in general as well educated as the average liberal arts graduate. In fact, the engineer is often more well read than the liberal arts man.

As matters now stand, an engineering education is the most difficult of all educations, and I see no reason why it should be made still more difficult by compelling an engineering student to study such subjects as French, Chaucer, ancient history, Greek, and the theory of music before he at long last begins the study of the difficult subject matter of engineering.

—J. P. Woods, Director
Geophysical Laboratory
Atlantic Refining Co.

To the Editor:

I have read the editorial in your April, 1955, issue and I thought you did a swell job until you got down to the third paragraph from the end. There you talk about "who will carry on our technical know-how, run our great industrial plants." The weakness of that argument is that the people who are doing most to carry on the technical know-how are really not college graduates at all. Less than 10 per cent of them are.

I recognize that the tendency for academic training is greater in the aircraft industry than in most. Am still willing to bet, however, that less than 10 per cent of the production engineers in the aircraft industry on the West Coast are actually college graduates. I don't mean that a lot of them haven't taken technical and engineering courses.

In England, roughly 7 per cent of the production engineers in the aircraft industry are college graduates. This information I obtained the summer before last when spending some time with the then Aircraft Controller.

So I disagree with you on that

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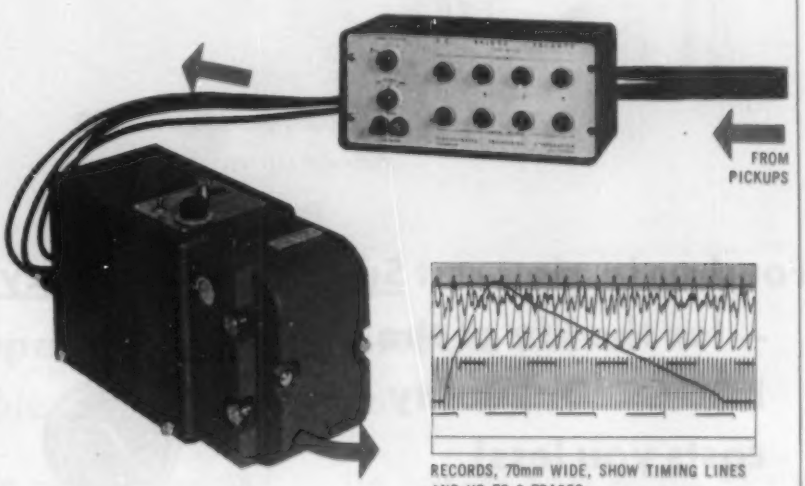
This simplified, low-cost test equipment should be in every engineering department. It fills the long-standing gap between pen-type recorders and complex oscillograph/amplifier systems... provides a high-speed graphic record of the physical conditions that affect the life of your product. Stress, strain, pressure, vibration, temperature... you can measure them all *at the same time*. And these small, lightweight instruments can be carried anywhere... little experience is required for their operation.



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point and therefore also disagree with Dr. Griswold and Dr. Rogers.

—ANDREW F. DEAN
Detroit, Mich.

Ed—I must agree with you that many of the individuals who are developing the technical know-how in our manufacturing plants are not college graduates. I do dispute your figure that less than 10 per cent of them are.

I have noticed that in the aircraft industry on the West Coast the bulk of the technical know-how is developed by men who are what they call production engineers in the production engineering department. Usually it takes both the graduate and the non-graduate.

I was very much interested in your 7 per cent figure concerning England. I am not surprised at that figure. I always thought American industry ran more to college graduates.

On one point I do disagree emphatically. You seem to lose sight of the fact that one action brings along with it another action. In many instances things start up in the engineering department and as they roll downward the the boys in the shop add their ideas. However, I wonder what other readers are going to say?

An answer to the "Put-Put" Question

To the Editor:

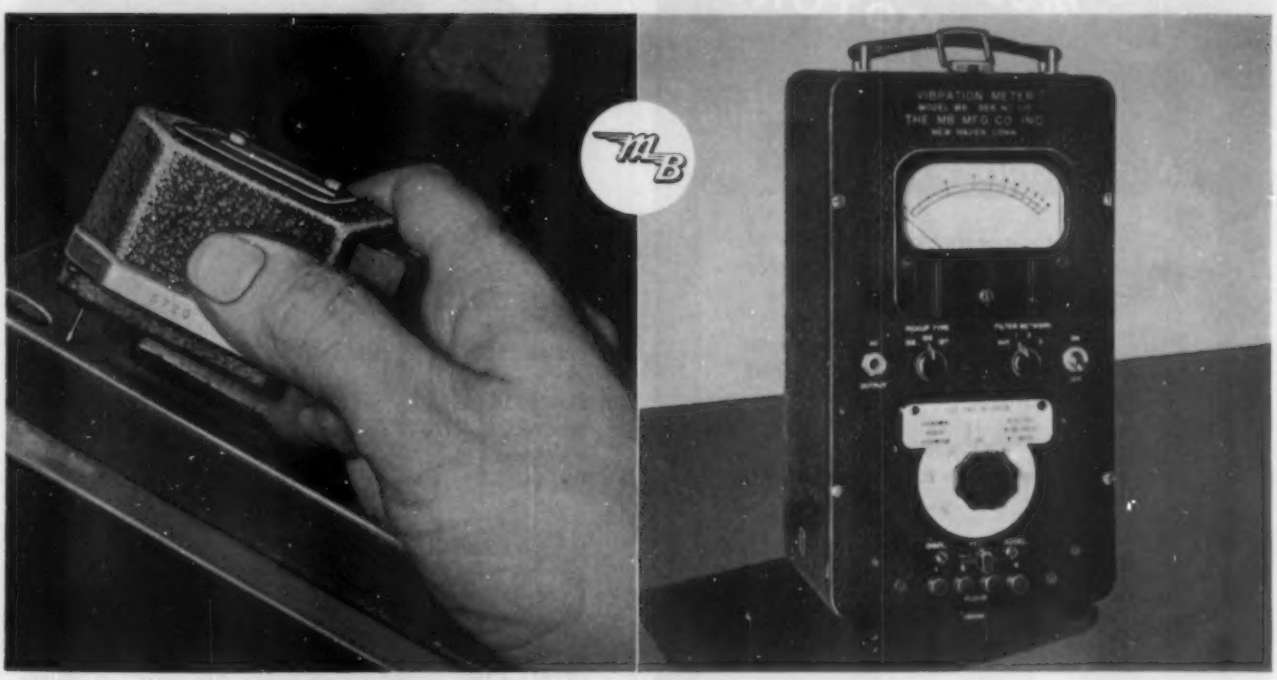
My attention has been called to your April issue, wherein a reader requests information concerning the principle of operation of a "put-put" toy boat. The explanation was given by J. G. Baker in an article, "Self-Induced Vibrations," ASME Transactions, Vol. 55, 1933, pp APM-55-2.

—R. E. PETERSON,
Westinghouse Electric Corp.

Correction

In a review of the "Bibliography On Unionization of Professional Engineers" published by the Engineering Societies Library, New York, N. Y., on page 310 of the April, 1955, *Product Engineering*, it was stated that references included publications dating from 1937 to 1944. This should have read from 1937 to 1954.

Two new "tools" to help you pin point vibration



MB Probe-type Pickup and Portable Meter

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With this new MB Type 115 Pickup, you can explore large panels . . . bearings, housing, structural members, bodies large and small. Since the light probe adds negligible loading or weight to the vibrating object, it translates any vibration into voltage with great accuracy for measurement. It lets you pin-point the trouble . . . determine quickly any need for corrective design.

The improved Model M6 MB Vibration Meter teams up with the pickup to give you the facts on vibration. With it, you measure the voltage generated in the pickup directly . . . in useful terms of amplitude, velocity, or acceleration of the vibratory motions.

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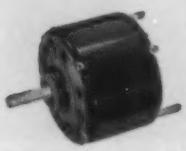

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4-pole, 4-coil shaded pole AC Induction Type

MODEL A
2-pole, shaded pole AC Induction Type

NEW MODEL E
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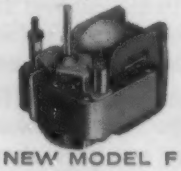
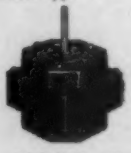
MODEL C
2-pole, shaded pole AC Induction Type

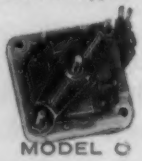


NEW MODEL F
2-pole, shaded pole AC Induction Type



MODEL D
4-pole, 4-coil, shaded pole AC Induction Type

Write for complete specifications and quantity-price quotations!



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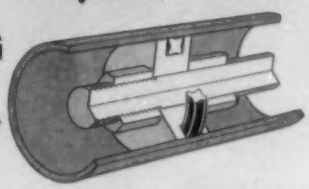
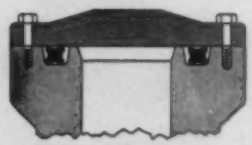


New design eliminates "spiral twist," common cause for packing failure. Users report much less drag and breakaway in installations with QUAD RINGS. Leading edge acts as wiper ring to minimize abrasion and prolong service life. QUAD RINGS form a positive seal under a wide range of pressures—are particularly efficient at 0 to 5 psi.



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QUAD RING design prevents excessive distortion under pressure. The four lips prevent "by pass" in devices using frequent pressure cycles. Reduced "working action" in the groove permits rougher groove finish. Made in a complete range of sizes corresponding with O-rings. Completely interchangeable with O-rings, eliminating any conversion costs.

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Field reports show many successful and easily serviceable applications of QUAD RINGS on rotating devices. QUAD RINGS permit much higher rotation speed and longer service life through reduction of friction.

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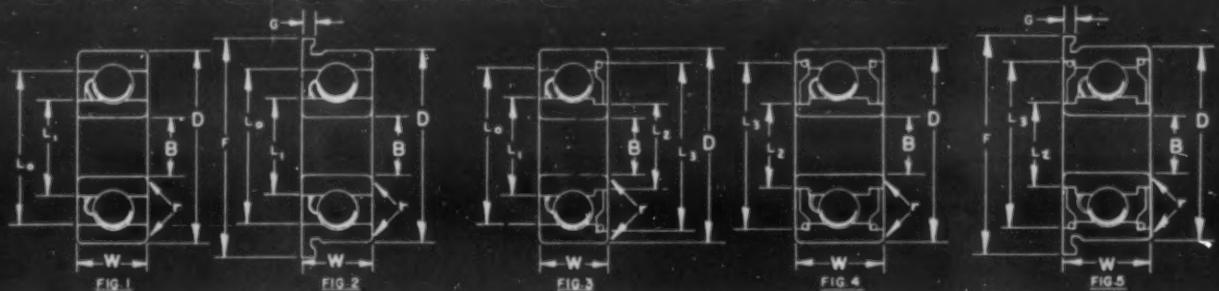

FIG. 1 FIG. 2 FIG. 3 FIG. 4 FIG. 5

BEARING NUMBERS								FR Brgs. only									
Unshielded		Single Shield Only	Single Shield (P) Double Shield (PP)														
Fig. 1	Fig. 2	Fig. 3	Fig. 4	Fig. 5	B +.0000 −.0002	D +.0000 −.0002	W +.000 −.001	r *	F ±.005	G +.000 −.003	Balls	L 1 ±.002	L o ±.002	L 2 ±.002	L 3 ±.002	C **** value (lbs.)	Max. Weight (Grms.)	Retainer
R0	FR0		R0PP	FR0PP	3/64 (.0469) 3/64 (.0469)	5/32 (.1562) 5/32 (.1562)	1/16 (.0625) 3/32 (.0937)	.005 .005	.203 .203	.013 .031	6, 1/32 6, 1/32	.085 .085	.125 .125	.076	.136	27 27	0.12	crown
R1	FR1	R1UP	R1PP	FR1PP	(.0550) (.0550) (.0550)	3/16 (.1875) 3/16 (.1875) 3/16 (.1875)	5/64 (.0781) 3/32 (.0937) 7/64 (.1094)	.005 .005 .005	.234 .234	.023 .031	6, 1 mm 6, 1 mm 6, 1 mm	.102 .102	.160 .160	.089 .089	.171 .171	41 41 41	0.20	crown
R1-4	FR1-4	R1-4UP	R1-4PP	FR1-4PP	5/64 (.0781) 5/64 (.0781) 5/64 (.0781)	1/4 (.2500) 1/4 (.2500) 1/4 (.2500)	3/32 (.0937) 7/64 (.1094) 9/64 (.1406)	.008 .008 .008	.296 .296	.023 .031	6, 3/64 6, 3/64 6, 3/64	.136 .136	.205 .205	.115 .115	.224 .224	57 57	0.42	crown *** or ribbon
R1-5	FR1-5	R1-5UP	R1-5PP	FR1-5PP	3/32 (.0937) 3/32 (.0937)	5/16 (.3125) 5/16 (.3125)	7/64 (.1094) 9/64 (.1406)	.008 .008	.359 .359	.023 .031	6, 1/16 6, 1/16	.161	.254	.140 .140	.265 .265	94 94	0.85	*** cr. or rib.
R2-5	FR2-5	R2-5UP	R2-5PP	FR2-5PP	1/8 (.1250) 1/8 (.1250)	5/16 (.3125) 5/16 (.3125)	7/64 (.1094) 9/64 (.1406)	.008 .008	.359 .359	.023 .031	6, 1/16 6, 1/16	.181	.273	.164 .164	.284 .284	96 96	0.64	crown
R2	FR2		R2PP	FR2PP	1/8 (.1250)	3/8 (.3750)	5/32 (.1562)	.012	.434	.042	7, 1/16	.204	.296	.184	.307	108	1.6	*** cr. or rib.
R3	FR3		R3PP	FR3PP	3/16 (.1875) 3/16 (.1875)	1/2 (.5000) 1/2 (.5000)	5/32 (.1562) (.1960)	.012 .012	.565 .565	.042 .042	6, 3/32 6, 3/32	.267	.409	.246	.420	201 201	2.76	crown
R4	FR4		R4PP	FR4PP	1/4 (.2500)	5/8 (.6250)	(.1960)	.012	.690	.042	8, 3/32	.366	.511	.346	.521	228	4.45	crown
R133	** FR133				3/32 (.0937)	3/16 (.1875)	1/16 (.0625)	.005	.234	.018	7, 1/32	.120	.160			31	0.092	ribbon
R144	FR144	R144UP	R144PP	FR144PP	1/8 (.1250) 1/8 (.1250)	1/4 (.2500) 1/4 (.2500)	3/32 (.0937) 7/64 (.1094)	.006 .006	.296 .296	.023 .031	8, 1 mm 8, 1 mm	.166	.218	.157 .157	.229 .229	52 52	0.28	ribbon
R155	FR155	R155UP	R155PP	FR155PP	5/32 (.1562) 5/32 (1562)	5/16 (.3125) 5/16 (.3125)	7/64 (.1094) 1/8 (.1250)	.008 .008	.359 .359	.023 .036	8, 1 mm 8, 1 mm	.217	.273	.217 .217	.284 .284	51 51	0.69	crown
R156	FR156	R156UP	R156PP	FR156PP	3/16 (.1875) 3/16 (.1875)	5/16 (.3125) 5/16 (.3125)	7/64 (.1094) 1/8 (.1250)	.008 .008	.359 .359	.023 .036	8, 1 mm 8, 1 mm	.217	.273	.217 .217	.284 .284	51 51	0.58	crown
R166	FR166		R166PP	FR166PP	3/16 (.1875) 3/16 (.1875)	3/8 (.3750) 3/8 (.3750)	1/8 (.1250) 1/8 (.1250)	.008 .008	.421 .421	.023 .031	8, 1/16 8, 1/16	.240	.320	.219	.331	120 120	1.2	ribbon
R168	FR168		R168PP	FR168PP	1/4 (.2500) 1/4 (.2500)	3/8 (.3750) 3/8 (.3750)	1/8 (.1250) 1/8 (.1250)	.008 .008	.421 .421	.023 .036	10, 1 mm 10, 1 mm	.283	.335	.283	.345	65 65	0.77	ribbon
R188	FR188		R188PP	FR188PP	1/4 (.2500) 1/4 (.2500)	1/2 (.5000) 1/2 (.5000)	1/8 (.1250) 3/16 (.1875)	.010 .010	.546 .546	.023 .045	7, 3/32 7, 3/32	.312	.436	.291	.447	226 226	1.7	ribbon
R613M					6 mm (2362)	13 mm (.5118)	3.5 mm (.1378)	.017			7, 3/32	.312	.436			226	1.7	ribbon

NEW HAMPSHIRE Specify Micro BEARINGS BALL BEARINGS, INC.
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MATERIALS: Chrome Steel Type SAE52100
Stainless Steel (prefix S) Type 440

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* r is max radius of shaft or housing fillet bearing will clear.
** FR133 has fillet (.005 max. radius) instead of undercut.
*** Add suffix D for ribbon retainer these bearings only.
**** See Catalog for load calculations.

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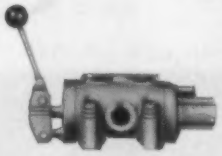

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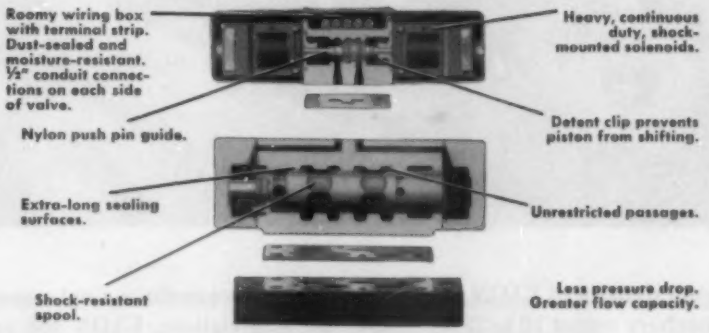
Roomy wiring box with terminal strip. Dust-sealed and moisture-resistant. ½" conduit connections on each side of valve.
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Less pressure drop. Greater flow capacity.

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INFORMATIVE LITERATURE

"3rd — I can count on longer life as well as the rated performance of Rivett Valves. They are designed and built for accurate circuit control."

"4th — Rivett valve catalogs are complete with specifications and drawings. Write for #204 and #260."

RIVETT LATHE & GRINDER, INC., DEPT. PE-6 BRIGHTON 35, BOSTON, MASSACHUSETTS

RIVETT furnishes a complete power package

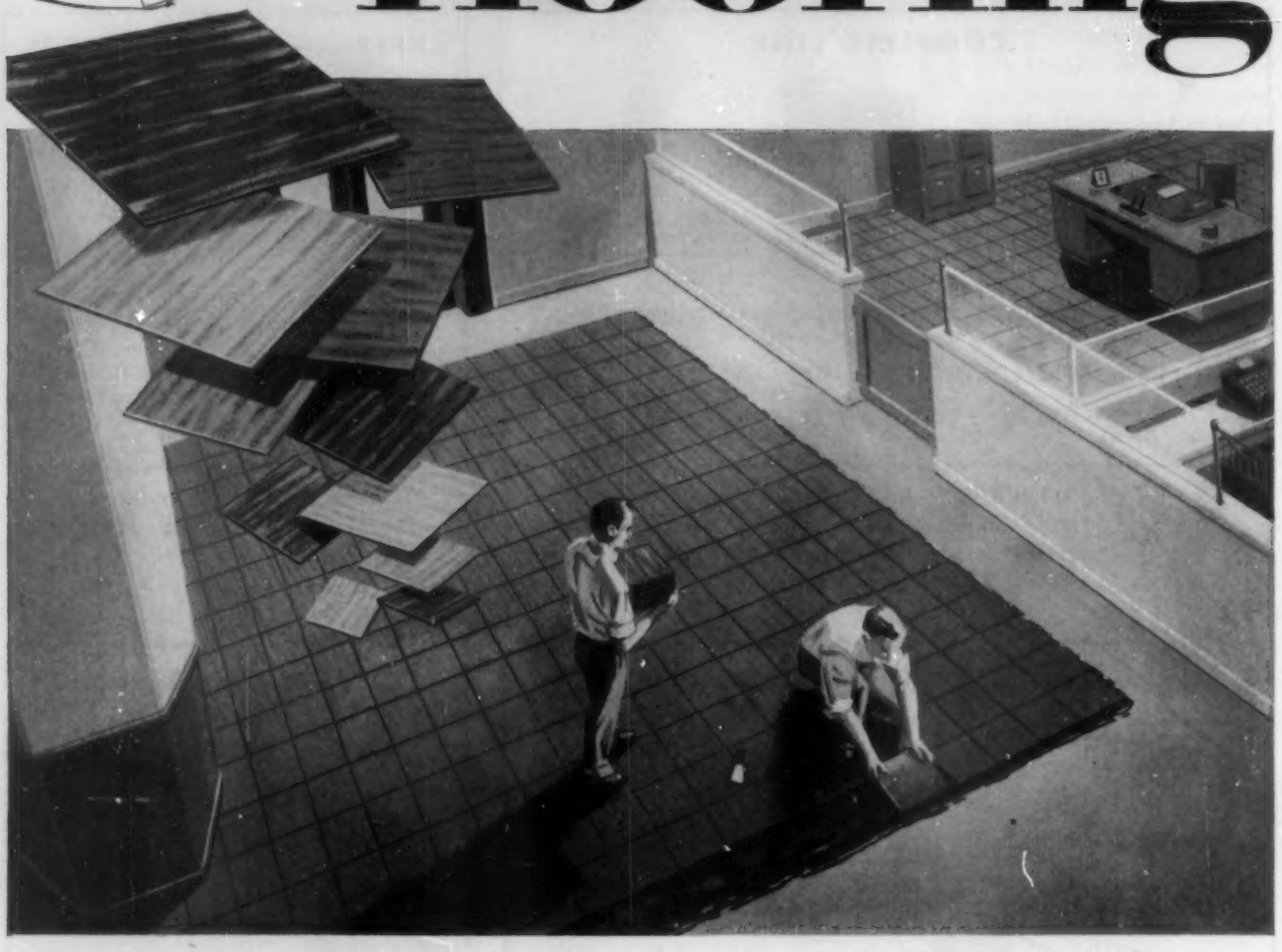
AIR AND HYDRAULIC — VALVES, CYLINDERS, POWER UNITS

EXON: each resin engineered for a specific problem

EXON 468

specifically for

flooring



Higher bulking density of EXON 468 increases the banbury output 10 to 25%! It makes processing easier, since it permits fast fusion at reduced temperatures.

A superior resin in every respect, EXON 468 offers good heat and light stability, high thermoplasticity, compatibility with conventional vinyl plasticizers, stabilizers and pigments.

Used as the base resin in vinyl asbestos floor tile formulations, EXON 468 provides new production economies — and superior end products.

For suggestions on developing new products, or improving established ones with EXON 468—or for complete information or technical service on the growing line of versatile EXON resins, contact:

Firestone

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CHEMICAL SALES DIVISION
FIRESTONE PLASTICS COMPANY, POTTSTOWN, PA., DEPT. 6-P
DIVISION OF THE FIRESTONE TIRE & RUBBER COMPANY

Bundy solves refrigeration problem with unique tubing strainer design

Read how Bundy Engineers work with designers to help make better products

As a designer, you undoubtedly know that Bundy is the leading manufacturer of small-diameter steel tubing. You've probably seen it specified many times.

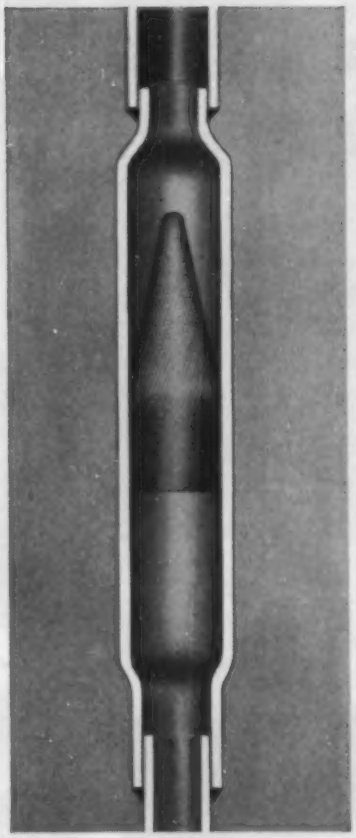
But, for *you*, there is more than manufacturing going on at the Bundy Tubing Company.

Shown at the right is a typical example of the help you can get at the design stage of your product. It is just one of hundreds of contributions which have been made by our engineering staff, in many widely diversified fields.

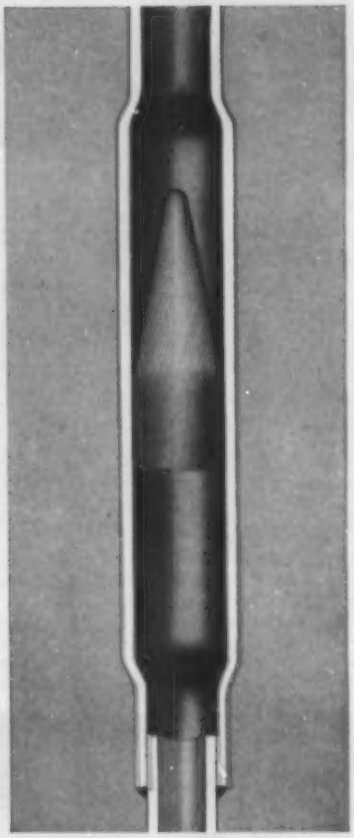
Take advantage of this unbeatable Bundy combination: expert, free engineering service plus genuine Bundyweld Tubing, the only tubing double-walled yet stronger; has high thermal conductivity, high bursting strength; takes easily to any fabricating operation. It is the safety standard of the refrigeration industry, *and is used in 95% of today's cars, in an average of 20 applications each.*

Let Bundy help you with that tubing design problem. Call, write, or wire us today:

BUNDY TUBING COMPANY
DETROIT 14, MICHIGAN



Problem: Because refrigeration systems can be quickly ruined by dirt particles which lodge in capillary tubes, most systems use a separate strainer assembly, as shown above. The two extra solder joints used to install the strainer assembly give rise to an even greater problem—leakage. Expensive hand assembly methods also frequently introduce dirt into the system.



Solution: New Bundy design actually makes strainer an integral part of condenser coil. The coil end is expanded to receive the strainer or filter and then swaged down to capillary size. This ingenious design eliminated one solder joint with its consequent risk of leakage or dirt inclusions; resulted in a cost savings of 50% to the customer.

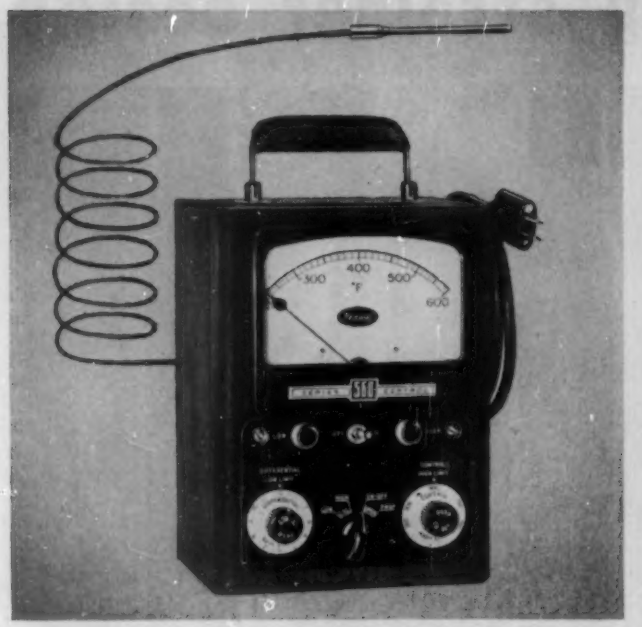
Bundyweld starts as a single strip of copper-coated steel. Then it's
. . . continuously rolled twice around laterally into a tube of uniform thickness, and passed
through a furnace. Copper coating fuses with steel. Result . . .
SIZES UP TO ¾ O.D.
Bundyweld, double-walled and brazed through 360° of wall contact.

NOTE the exclusive Bundy-developed beveled edges, which afford a smoother joint, absence of bead, and less chance for any leakage.

BUNDYWELD TUBING®

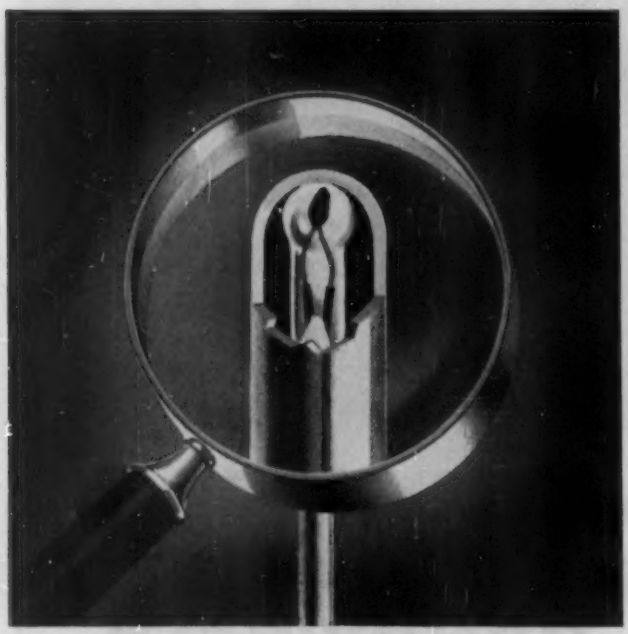
DOUBLE-WALLED FROM A SINGLE STRIP

Which of these two instruments provides the temperature control accuracy you need?



1. IT'S ELECTRONIC! The new Series 560 applies the thermistor principle in temperature indicator controls with heretofore unattainable accuracy over a scale range of 200° to 600°F. It's the *only* instrument that provides the three major control modes — (1) on-off (2) proportional (3) adjustable differential — all at the flip of a switch. Wide range of use for general laboratory, processing, molding or packaging applications.

2. IT'S MECHANICAL! The new Series 540 indicating controller combines low cost with high accuracy over a temperature range of 100° to 700°F. Temperature changes are transmitted by a bulb and bellows to an indicator control. Instrument features on-off control . . . adjustable differential . . . ambient compensation. May be flush or surface mounted. Capacity of 15 amps at 115 volts.



3. SIMPLICITY ITSELF is secret of Fenwal's Series 560 — accuracy, sensitivity and ruggedness. The thermistor's high resistance change permits operation with any length of lead wire up to 200 feet without affecting signal strength or accuracy. Thermistor is hermetically sealed in glass for stability; encased in stainless steel for ruggedness. No complex circuitry; maintenance is easy.

4. EASY "SET" AND "CHECK" OPERATION is a feature of Fenwal's Series 540 which is accurate to within 2% over the 100° to 700°F range, including the effects of ambient temperatures. Send for FREE NEW BULLETINS, MC122 on the Series 540, MC123 on the Series 560. Both contain full data you should have. Write to **Fenwal Incorporated, 26 Pleasant St., Ashland, Mass.**

Fenwal Controls Temperature... *Precisely*

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COMMERCIAL HAND DRYER

Seamless Drawn Vitreous Enameled
Length . . . . . 12"
Width . . . . 10½"
Height . . . . . 6¾"

DEEP FAT FRYER POT

Seamless Drawn Stainless Steel
Height . . . . 12"
Length and Width . . 12½"

WASHING MACHINE TUB

Seamless Drawn Vitreous Enamaled
Height . . . . 14¼"
Diameter . . . . . 22"

TUB AND COVER FOR PORTABLE DISHWASHER

Seamless Drawn Aluminum, Baked Enamel Finish
Height of Tub . . 11"
Length and Width 17"

BASE FOR SWIVEL CHAIR

Seamless Drawn Carbon Steel
Length 23", Height 4"

CONTACT...

G P & F

MEAT GRINDER PAN

Seamless Drawn Stainless Steel
Height of Pan . . . 2"
Length . . . . . 21"
Width . . . . . 11¹³⁄₁₆"

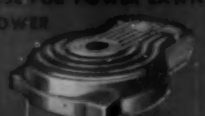
VACUUM CLEANER PARTS
Carbon Steel

Largest Cup is 3½" Deep, 6½" Dia.
Guard is 14" Long, 4⅝" Wide

COVER, FUNNEL AND TANK FOR SOAP DISPENSER UNIT

Seamless Drawn Brass
Height of Tank 7"
Dia. of Tank 4¼"

BASE FOR POWER LAWN MOWER



Seamless Drawn Steel
Length 26", Width 19¼"
Height 4⅝"

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Polished Stainless and Plated Carbon Steel
Overall Height . 17"
Dia. of Base . . . 8"

It is our business to make large and medium size seamless drawn stampings for your business. We do it so well that the names of our customers makes up a "blue chip" list of American industry.

That's why we say: if you have a product that needs stamped or deep drawn metal parts . . . if you demand top quality workmanship and on-time delivery . . . contact G. P. & F. Our facilities for fabricating, finishing and assembling can relieve you of production details and headaches . . . add dollars-and-cents economies to your plans.

Write today for a copy of our booklet—"Science and Skill in Sheet Metals." It illustrates many jobs produced for our customers . . . and tells all about us.

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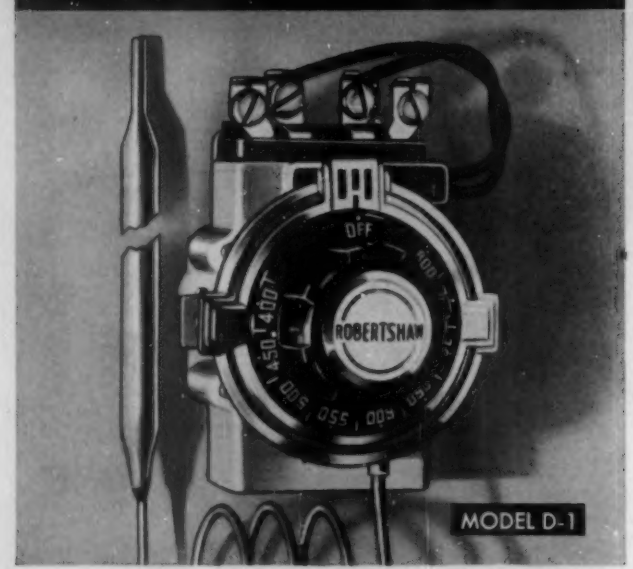
your *TOUGHEST*
Heat Control problems
no matter how tough!



DOUBLE POLE SINGLE THROW DIRECT-ACTING THERMOSTAT MERCURY-ACTUATED. TEMPERATURE RANGE TO 800°F RATING 35 AMPS., 125V AC; 25 A, 250V AC.

Wherever you need help in controlling heat—positive, dependable thermostatic control, either direct or reverse-acting types—single and double pole; single and double throw; single and double circuits; with and without limit switches—you'll find it pays to turn to Robertshaw® controls. You can choose a ruggedly-built control of extreme accuracy and sensitivity for a wide range of heating applications, with maximum of 800° and differentials to meet your particular application requirements. Robertshaw is the largest manufacturer of thermostats for commercial and industrial applications. For a full discussion of your specific needs, write today:

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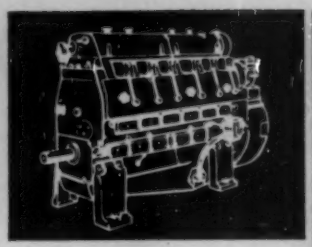
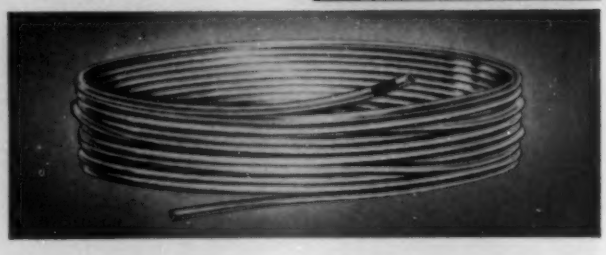
CONTROLS COMPANY

Robertshaw Thermostat Division, Youngwood, Pennsylvania
Robertshaw-Fulton Controls (Canada) Ltd., Toronto

Largest manufacturer of thermostats for commercial and industrial applications.



Design with economy in mind...



Lubricating lines of Alcoa Utilitube are easily formed, long lasting, more economical

ALCOA® Utilitube, coiled aluminum tube made of a special ALCOA alloy, offers many advantages for use as oil and grease lubricating lines, as proven in hundreds of applications.

ALCOA Utilitube will not deteriorate lubricating oils, or cause sludge or gum formations in lubricants. It is light, easy to handle, and is available in long lengths, up to 1,000 feet or more. ALCOA Utilitube is strong, too . . . has high fatigue strength, good bursting strength, good flaring and forming characteristics, work hardens less under repeated bending.

ALCOA Utilitube is economical to use . . . actually offers savings up to 40% over other corrosion-resistant metal tube.

In addition to lubricating lines, you can use ALCOA Utilitube for refrigerants, air, oil and other fuel lines, and for hydraulic fluids. When the design calls for coiled tube, *specify Alcoa Utilitube*.

Write today for ALCOA's FREE booklet, *Alcoa Utilitube*. It's full of design information on this versatile ALCOA product.

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ALCOA ALUMINUM
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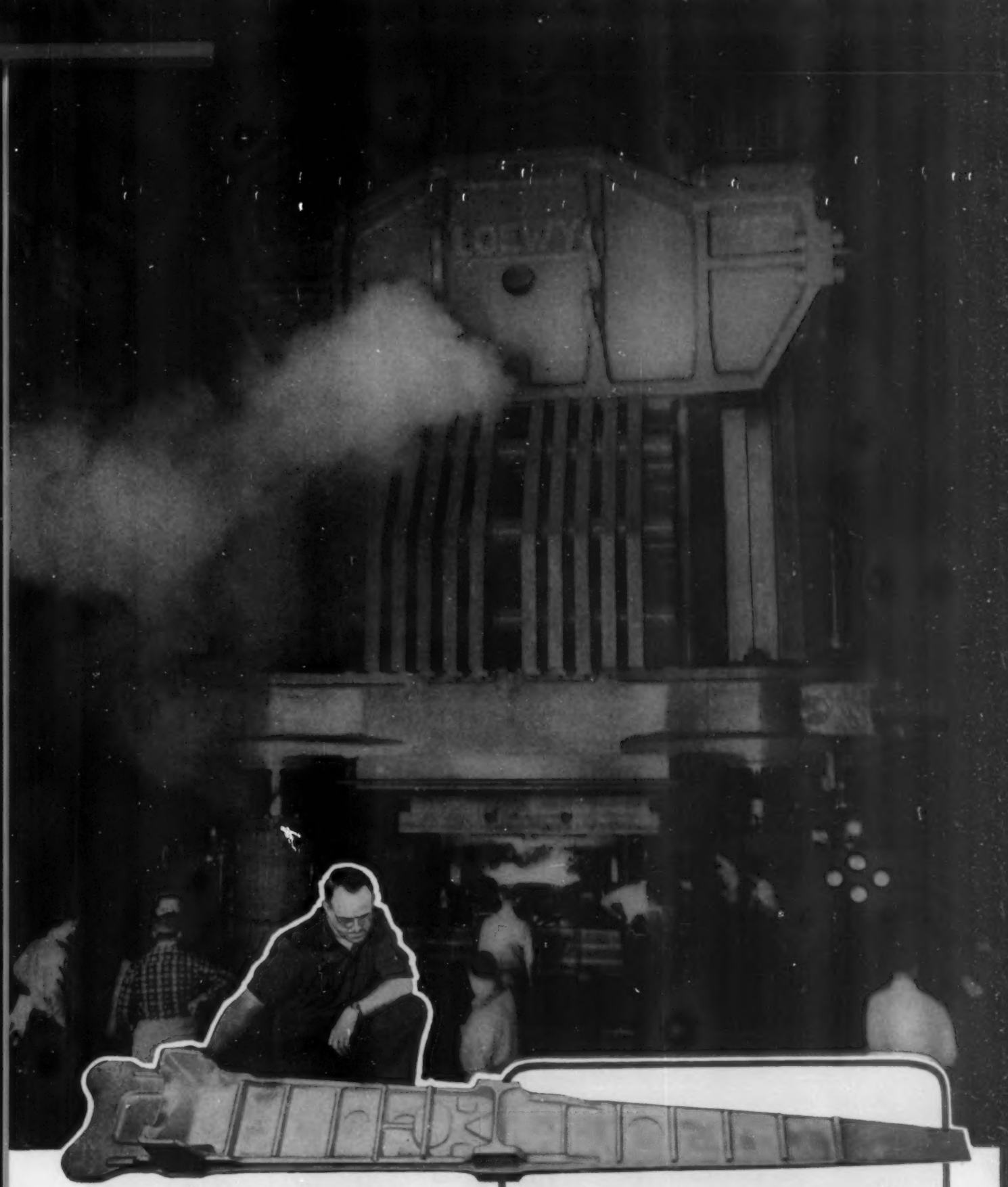


A new era in the art of forging has been established as production goes forward on this 35,000-ton closed die forging press. Larger forgings with closer tolerances than heretofore possible open new concepts in forging design. Wyman-Gordon continues to pioneer by—*Keeping Ahead of Progress.*

WYMAN-GORDON CO.

Established 1883

FORGINGS OF ALUMINUM • MAGNESIUM
STEEL • TITANIUM

WORCESTER 1, MASSACHUSETTS
HARVEY, ILL. • DETROIT, MICH.

The man who needs a new machine tool and doesn't buy it is paying for it anyway...

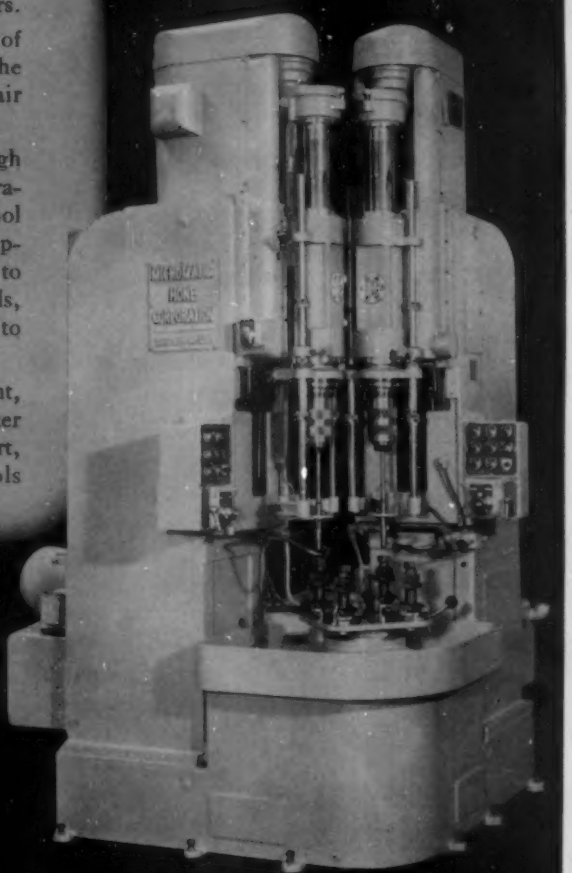
in high maintenance costs

LOOK beyond the age of your equipment when considering whether maintenance costs indicate your need for new machine tools. The design of equipment and the method of processing used are equally important factors.

For example, fast spindle speeds and the necessity of maintaining perfect alignment between spindle and the fixture or chuck, call for frequent adjustment, repair and replacement of parts.

You can greatly reduce such maintenance costs through the Microhoning* process—which employs comparatively slow spindle speeds and self-alignment of tool and workpiece. And the design of Microhoning equipment makes easily accessible all components likely to require servicing...follows industry-accepted standards, such as the J.I.C. electrical and hydraulic codes, to provide greater safety to both operator and machine.

In reviewing your processing methods and equipment, you may discover your maintenance costs are greater than the price of new Microhoning equipment. In short, you may be paying right now for new machine tools you don't have.



PART:
Cluster gear—bore must be straight and concentric with gear teeth.

PROBLEM:
Excessive maintenance costs on fixture driver and chucks.

SOLUTION:
MICROHONING — Simple stationary fixture — self-aligning tools — straight bore concentric with gear teeth — increased production.

*MICROHONING = STOCK REMOVAL + GEOMETRY + SIZE CONTROL + SURFACE FINISH

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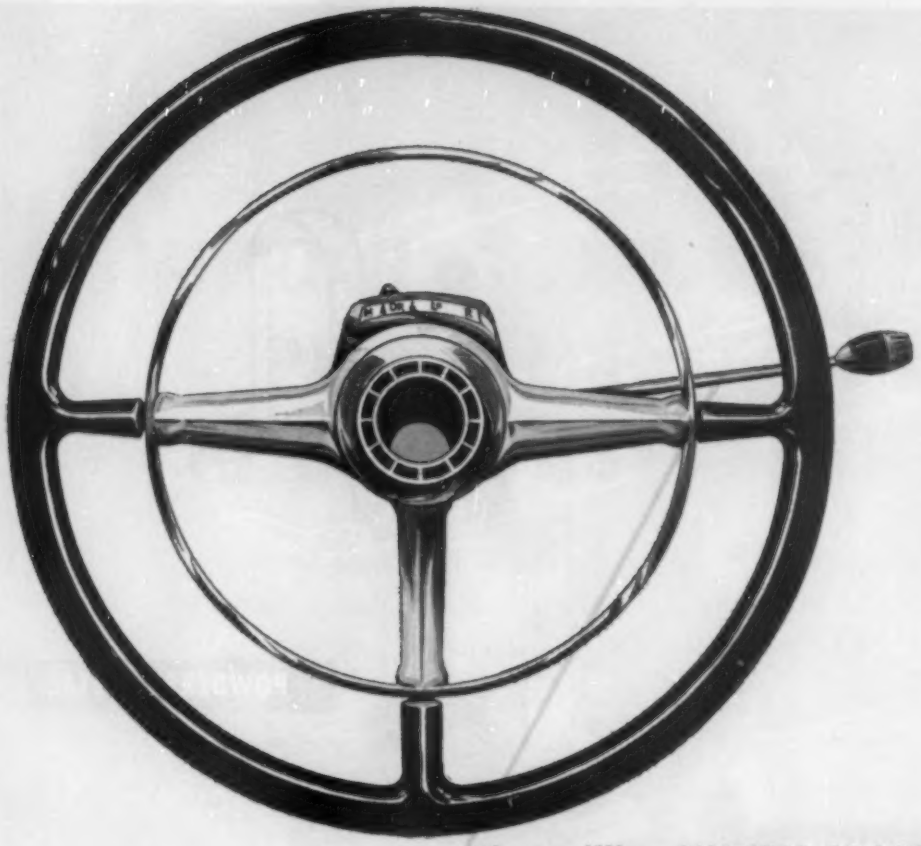
MICRO-PRECISION DIVISION • 2205 Lee Street, Evanston, Illinois
Hydraulic controls • Diesel fuel injection equipment

Visit Booth 1211 at the Show. See other examples of how Microhoning saves on maintenance.



How a shift in gears saved $256,000

Five million MUELLER BRASS CO. forged ring gears improve automatic transmission operation . . . at lower cost to the manufacturer.

Ever since one of the leading manufacturers of automotive transmissions began using ring gears forged from Mueller Brass Co. bearing bronze, production costs have been cut nearly $256,000. That's because the rough forging weighs less and is closer to finished size than a sand cast ring gear formerly used. This shift in gears resulted in a savings in metal costs, greatly reduced machining time and increased tool life. In addition, the use of forged gears has cut scrap loss and eliminated costly inspection rejects.

The performance of these forged ring gears is also far superior to the sand cast gear, which had a tendency to flake away and crack around the teeth, causing failures. More than five million forged ring gears have now been used in these transmissions without a single failure. Being porous, the sand casting was difficult to balance, but the forging has a dense, homogeneous structure that helps keep it in perfect balance.

Strong, long-wearing non-ferrous metal parts, forged to your specifications by Mueller Brass Co., can help reduce your costs and improve the performance of your products just as they have done in this transmission application. For complete information, write us today.

Write today for your complete set of Mueller Brass Co. engineering manuals.

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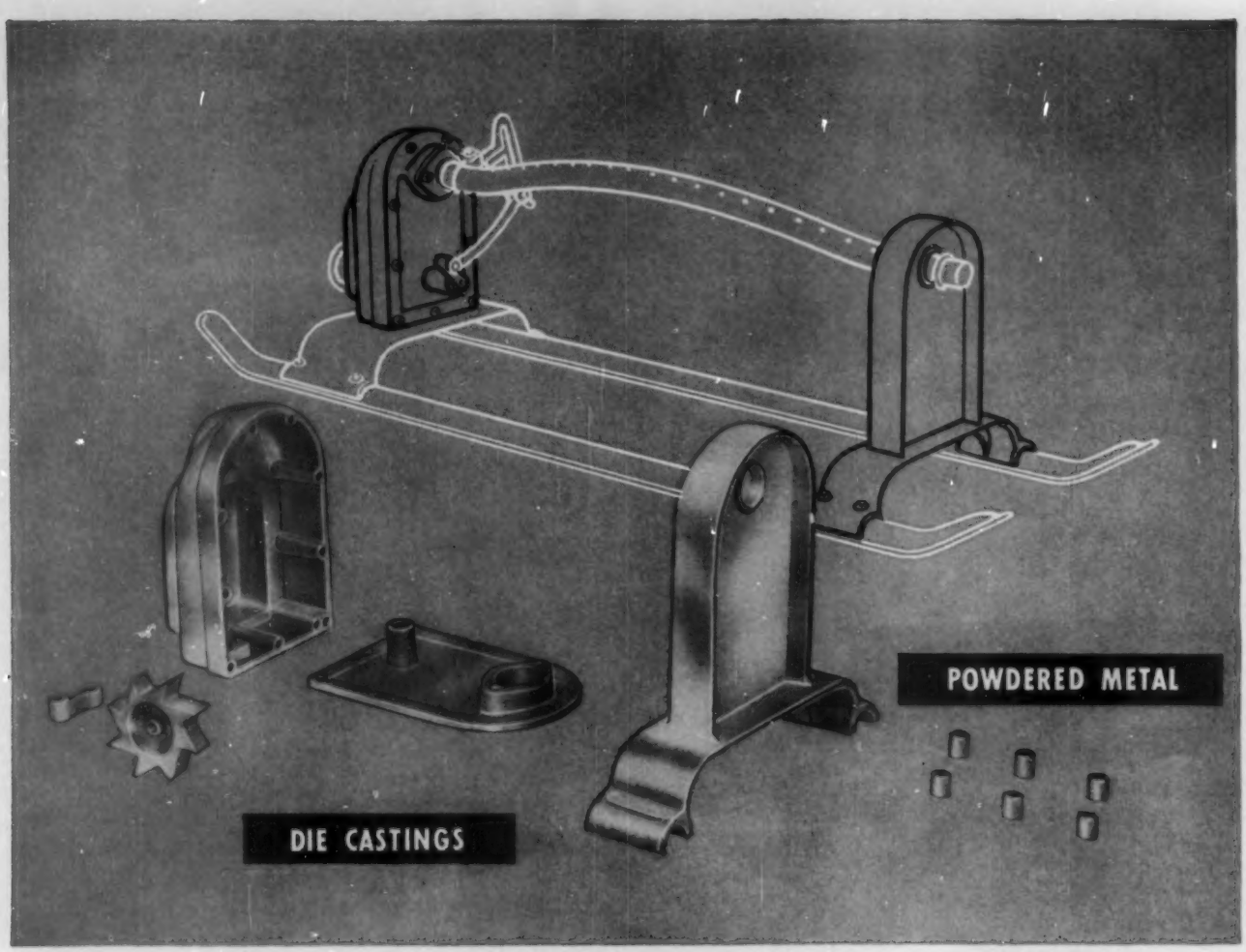

PARKER USES 2 MEANS TO 1 *Lower Cost* END

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This example emphasizes an important point about Parker service. No matter what your requirements in either die castings or powdered metal, Parker has the skill, experience and facilities to provide either or both. This undivided responsibility has saved money—and solved problems—for many users. Your problem may be one that Parker can solve in like manner. Just call the nearest Parker sales engineer listed at the left.

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PARKER **ALUMINUM and ZINC *die castings***

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IMPROVING PRODUCT PERFORMANCE IS OUR BUSINESS!

When the performance of your product can be improved with vibration control or with bonded-rubber components, you can rely on LORD for the most effective solution to your problem.

In the first place, you can benefit from LORD'S thirty years of experience devoted exclusively to designing and developing bonded-rubber products for every type application—with thousands of successful solutions in the "completed" file.

Second, you can draw upon LORD'S unparalleled knowledge of vibration problems and the designs and materials that produce the best results under any specific condition.

Third, LORD has extensive research and development facilities in addition to the Engineering Division and the LORD Field Engineers—all available and geared for immediate and effective action in solving product problems involving vibration control or bonded-rubber products.

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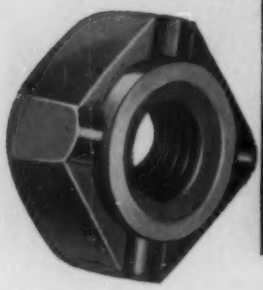
SPEED UP THE FABRICATING, FASTENING AND ASSEMBLING OF METAL PARTS WITH



MIDLAND WELDING NUTS!

Midland Welding Nuts may be the answer to your dreams if you're in a business which fabricates, fastens, or assembles metal parts—OR, if you're a designer of products incorporating such parts.

Midland Welding Nuts are welded to the parts to be worked so that bolts can be turned into them speedily—without the need for any device to hold them in place.

They're just the ticket for those hard-to-get-at places. And they stay put—will not work loose or rattle.

Relied on by manufacturers the world over—and specified universally by product designers—Midland Welding Nuts will lower your assembly costs, speed up operations all along the line for you.

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Read by Sight, Sound or Feel.

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in inch grams . . . inch ounces, . . . inch pounds . . . foot pounds (All sizes from 0-6000 ft. lbs.)

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might be your answer to better insulation at lower cost

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PLAIN

Fibrous sheet material for use as replacement for paper-base laminates where moisture absorption is not a critical factor. Arc resistance, tensile and impact strengths of DUROID 800 are greater than XP paper-base laminates. Listed by Underwriters' Laboratories.

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Moisture pick-up almost as low as paper-base laminates; flexural strength much higher. Specific coatings — such as alkyds, epoxies and vinyls — can be applied to obtain characteristics available only in much more expensive materials.

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Retains more physical strength after exposure to flame. Self-extinguishing, with no afterglow. Easy to fabricate. Your tests may prove it satisfactory for applications now using much more expensive materials.

For technical data or samples of any of the above materials, please write Dept. E, Rogers Corporation, Rogers, Connecticut.

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SHOE MATERIALS—for Counters, Midsoles, Liners, etc.
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SERVICES

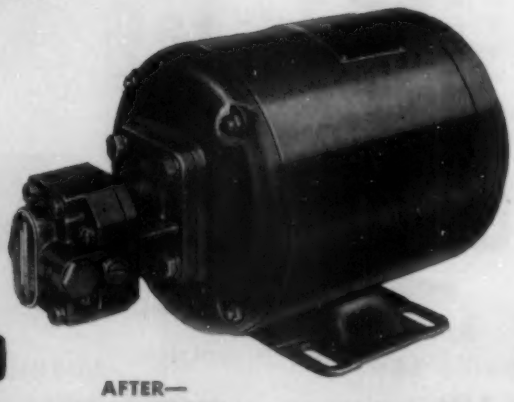
Research, Development, and Engineering of New Materials, Parts and Products • Fabricating, Combining, Coating, & Embossing

BARNES PUMPS TEAM UP WITH DOERR MOTORS

for better design

Constant-Flo motor pumps are smaller, weigh less, eliminate alignment problems.

BEFORE—
Conventional, separate pump and motor mounted on cast base plate.



AFTER—
Constant-Flo motor pump combination results in compact, lightweight unit.

HERE is a new "Pressure Package" made possible through a unique close-coupled construction. This line of rotary gear pumps, manufactured by the John S. Barnes Corporation, Rockford, Illinois, can deliver pressures up to 3000 psi. Motors are available in the NEMA 42, 56 and 66 frames in a range from ⅓ to 1½ hp.

The rapidly growing list of applications already includes automatic door operators, forced lubrication, filters, material stackers and elevators, crimping machines, vegetable dicers, fuel oil transfer, coolant pumps, chair lifts and machine tools.

This is another example of product improvement —the use of Doerr motors provided the manufacturer with the proper engineering features as well as a reliable source of supply. We would be pleased to consult with you on your motor applications.

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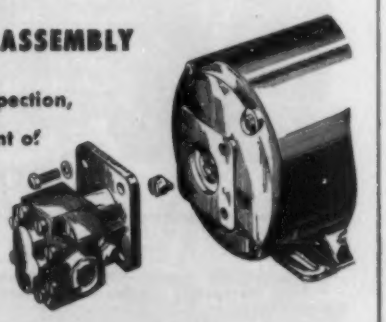
DOERR
Electric Corporation
CEDARBURG, WISCONSIN

Electric Motors from 1/30 to 5 hp. Standard or Designed to Your Specifications

SIMPLIFIED ASSEMBLY

Permits easy inspection, quick replacement of motor or pump.



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CORROSION CONTROL

in this 20-page KEL-F® Dispersions Manual

Learn how you can get the advantages of KEL-F fluorocarbon plastic: corrosion and heat resistance, anti-adhesion, abrasive resistance, excellent electrical properties, moisture resistance *in a dispersion coating, for application by spraying, dipping or spreading*

® Registered trademark of The M. W. Kellogg Company's fluorocarbon polymers

M KELLOGG W

THE M. W. KELLOGG COMPANY
Chemical Manufacturing Division
P. O. Box 469, Jersey City 3, N. J.

Please send me my copy of the new Kellogg Manual, "Application Techniques for KEL-F® Fluorocarbon Polymer Dispersions."

Name _____
Title _____
Company _____
Address _____
City _____ State _____

I am interested in Dispersion Coating Applications for:

- ☐ trailer tanks
- ☐ tankcars
- ☐ storage tanks
- ☐ pipe lines
- ☐ pumps
- ☐ mixers
- ☐ valves
- ☐ flowmeters
- ☐ reactors
- ☐ shipping containers
- ☐ waste neutralizers
- ☐ agitators
- ☐ calendering rolls
- ☐ forming dies
- ☐ guide rolls
- ☐ mattress molds
- ☐ tire molds
- ☐ ribbon blenders
- ☐ cone blenders
- ☐ hoppers
- ☐ casting molds
- ☐ coated glass tape
- ☐ miniaturized stators
- ☐ distribution transformers
- ☐ miniaturized relays

Other applications (please list) _____

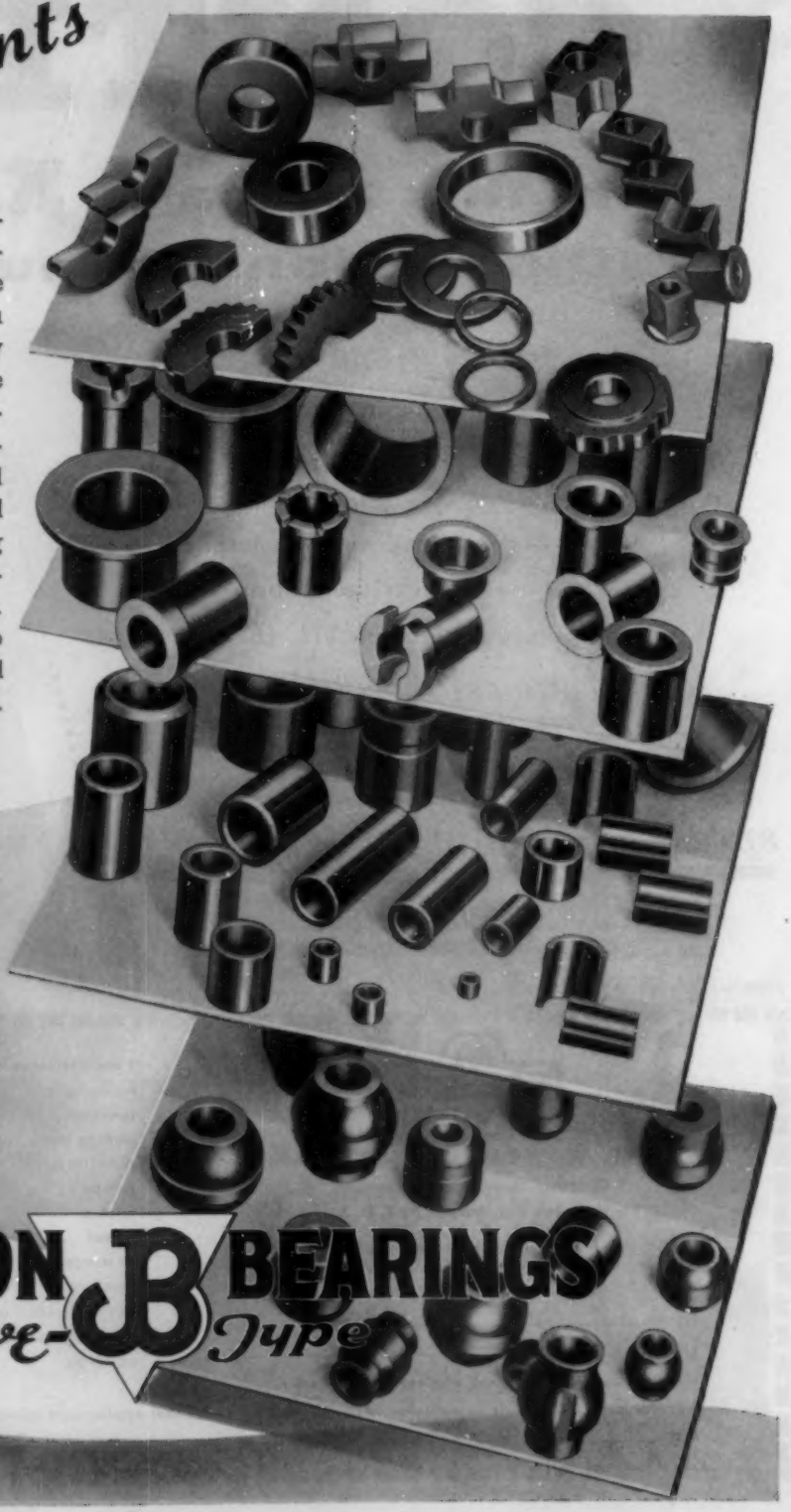
POWDER METALLURGY

BEARINGS
BUSHINGS
AND PARTS

Send us your blueprints

THERE are many applications where powder metallurgy bearings and parts give utmost service. In these cases you can save considerable money. They are molded to shape and require no machining. They are impregnated with oil and in service become self-lubricating. Ledaloyl powder metallurgy bearings and parts are ideal for self-aligning bearings and for applications difficult or impossible to lubricate. Johnson engineers will gladly help you decide whether you should use them. Write for appointment.

JOHNSON BRONZE CO.,
508 S. Mill St., New Castle, Pa.

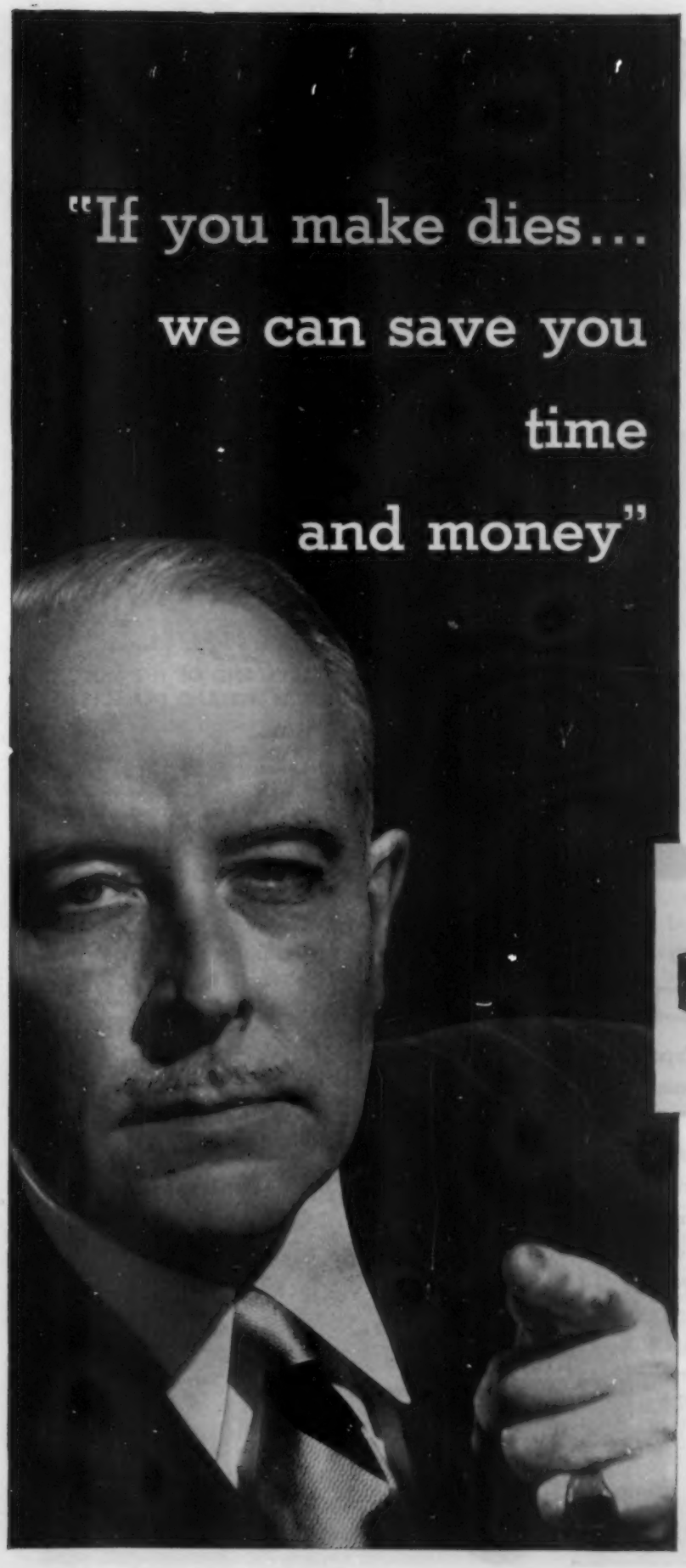


Ledaloyl
SELF LUBRICATING

SELF-
LUBRICATING

Many Sizes of plain, flanged and self-aligning bearings may be ordered from stock.

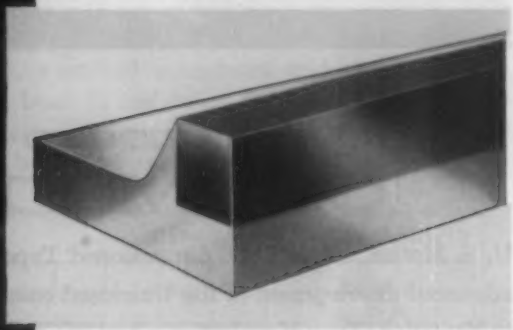
JOHNSON JB BEARINGS
Sleeve-Type



You save time because OK Composite Die Sections are carried in stock ready for immediate shipment to you. They are available for Cutting, Trimming and Forming Dies. You can order them cut to length or in bars 125" long. There are 11 standard cross sections with both wide and narrow lands.

You save money because you can buy them at a price far below what it would cost you to make them yourself. And the soft steel backing, to which uniformly hardened steel is clad, is drilled quickly and economically for dowel and screw holes. Adjustments for wear are equally simple.

Companies now using OK Composite Die Sections report great time and money savings over competitive products formerly used.



You'll be interested in receiving FREE a new Bulletin on OK Composite Die Sections and Clad Aluminum Bronze Wear Plates. Write Dept. **42 B.**

THE OHIO KNIFE CO.

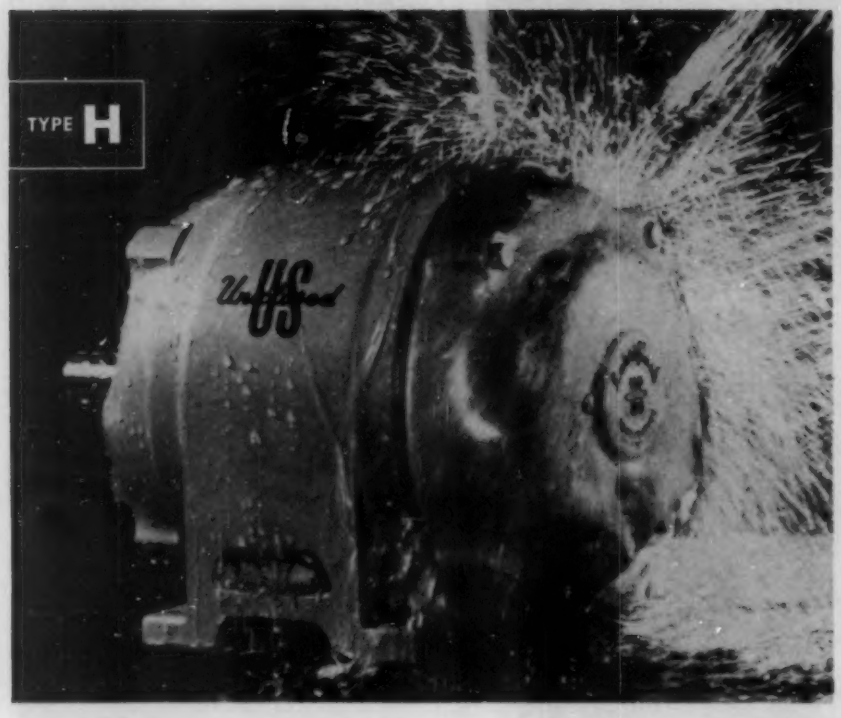
CINCINNATI 23, OHIO

Manufacturers for the Metal Working Industry of:

Slitter Knives • Shear Blades
Work Rest Blades • Cut-Off Blades • Hardened Spacers
Hardened Ways • Gibs • Ball Races • Bronze Ways
Wear Strips

NEW MOTOR PROTECTION

with INGENIOUS *Ventrifoil*

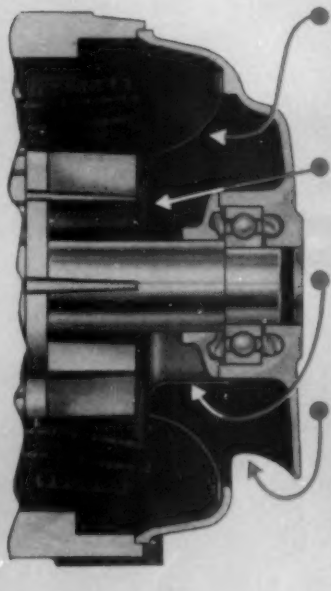


Ventrifoil

AT EACH END OF THE MOTOR DIRECTS AIR AND DEFLECTS WATER . . . Ventrifoil, a specially formed deflector, directs air around bearing housings and into fans on the rotor. By forming a "vestibule" between the bracket openings and the fan inlet, water is deflected and separated from the air stream without hindrance of the air flow to interior.

All New UNICLOSED TYPE H U. S. MOTOR

U. S. Motors new NEMA dimensioned Type H motor is an advanced development of the Uniclosed concept. In addition to Ventrifoil, Type H embodies a host of revolutionary exclusive features, such as improved asbestos-protected windings to add years to motor life; Lubriflush transverse lubrication for greatly increased bearing life; normalized castings; improved solid cast rotor; all directed to the objective of longer motor life and more efficient power.



VENTRIFOIL
Securely fastened to inside of bracket to direct air and deflect water. Does not interfere with assembly of motor.

AIR PASSAGE
Air is brought in at bottom but enters motor only through top half of deflector.

CURVED WATER FOIL
A curved projection of the Ventrifoil is concentric with the shaft and prevents entrance of water.

PROTECTED VESTIBULE
After entering bracket openings, air flows upward at low velocity through a protected chamber within bracket before reaching motor windings.

Mail Coupon for informative full-color 12-page Type H Bulletin ➧

U. S. ELECTRICAL MOTORS Inc. PEN-6
P. O. Box 2058, Los Angeles 54, Calif., or
Milford, Conn. Send Type H Bulletin No. F-1856

NAME_____

COMPANY_____

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MOTORS US

U. S. MOTORS

700,000 Zn Die Cast per day...

how else would you make them?

THIS ACCOMPLISHMENT IS TYPICAL of a process that can mass-produce—direct from the raw material—precise, complex-shaped close tolerance units economically. In the fast-moving automotive industry, designing with die castings ensures the high-speed and economical production of many components. This year, for example, the industry needs 76 million door and window handles. These handles are being zinc die cast at the rate of 700,000 per day—how else would you do it?

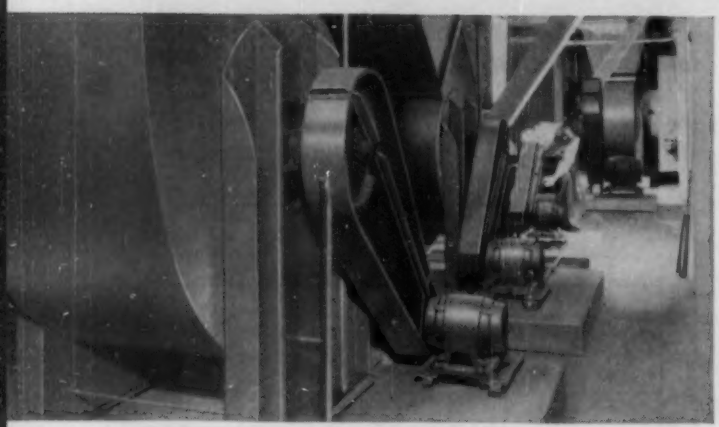
On the 1955 cars the front end assemblies alone of 16 different models contain from 22 to 40 pounds of zinc die cast parts each. The excellent physical properties of zinc are also increasingly utilized for a great variety of functional automotive parts. Because die casting actually is the "shortest distance between raw material to finished product," it is the outstanding production technique for innumerable components of home appliances, instruments, hand tools, business machines, electrical equipment and many other products basic to the American economy. In fact, the die casting industry consumes over one-third of the total zinc used annually in this country.

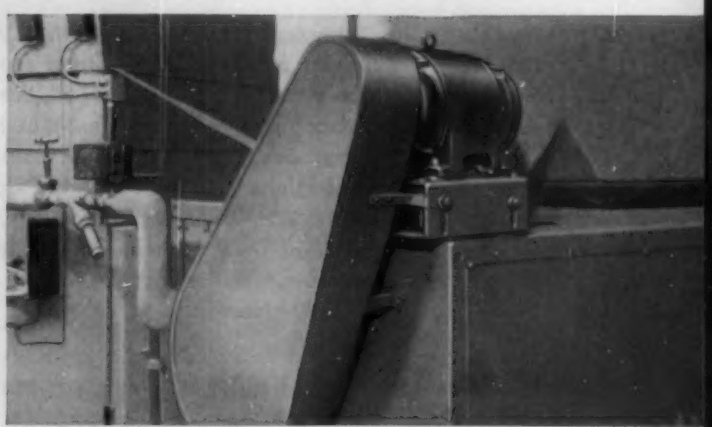
Source: American Die Casting Institute.

BUNKER HILL 99.99+% ZINC

EASTERN SALES AGENTS ST. JOSEPH LEAD COMPANY 250 PARK AVENUE, NEW YORK 17
SALES OFFICE FOR PACIFIC COAST NORTHWEST LEAD COMPANY SEATTLE, WASHINGTON

San Francisco International Terminal's Ideal Climate





Created by American Blower

Air—fresh air, and plenty of it—is supplied to the 16,000 daily passengers at the new San Francisco International Airport Terminal Building by American Blower equipment.

The fifty supply and exhaust fans are driven by powerful Fairbanks-Morse motors—selected to fit the prime requirements of quiet, dependable, efficient performance at low cost, and with little maintenance.

Powered by Fairbanks-Morse

When next you look for quiet, efficient, low-maintenance motor performance—look for the famous F-M Seal and see the difference that quality makes. Fairbanks, Morse & Co., 600 South Michigan Ave., Chicago 5, Illinois.

FAIRBANKS-MORSE

a name worth remembering when you want the best

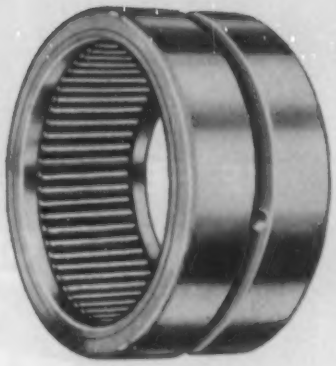
ELECTRIC MOTORS AND GENERATORS • DIESEL LOCOMOTIVES AND ENGINES • PUMPS • SCALES • RAIL CARS • HOME WATER SERVICE EQUIPMENT • MOWERS • MAGNETOS

Which of these ORANGE ROLLER BEARINGS is best for your application?

Look over this "family" of Orange Roller Bearings. Each type is designed to provide outstanding performance under specific conditions. When matched to your operating requirements, they can solve many design problems—cut costs—save space—speed up assembly — provide quiet, long-life, trouble-free operation.

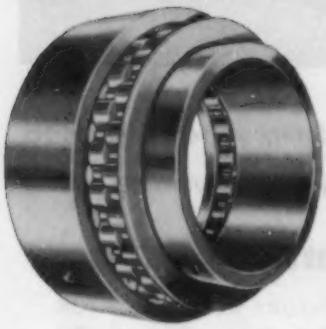
- *Submit details or drawings for recommendation*
- *Field engineers available for consultation*
- *Engineering Data Books sent on request*

ORANGE ROLLER BUSHINGS



Maximum load capacity in small space

Install these space-saving full-type needle bearings to provide friction-free, long-life operation of rotating or oscillating parts. Electronically-gauged rollers permit closer internal running clearances, minimizing possibility of misaligned rollers. Quiet, even-running. Stock sizes ½" to 8" shaft diameters.



For heavy loads—severe service ORANGE "STAGGERED" ROLLER BEARINGS

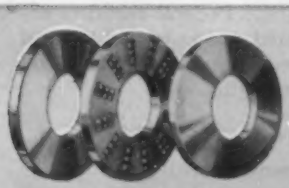
Staggered Conventional

End views show how staggered roller arrangement distributes load over many short rollers, compared with conventional bearings. Often permits use of smaller bearings—always assures longer service life. Also prevents skewing tendencies of long rollers, provides more even running. All standard, fully interchangeable sizes.

ORANGE *Cage Type* NEEDLE BEARINGS

Prevent Roller Skewing

Anti-friction cage keeps rollers permanently aligned and true-running in any position—vertical, tilted, horizontal. Successful on overhung mountings and relatively high-speed installations. Less affected by misaligned mountings or uneven loading. Extremely smooth, quiet running. Sizes ½" to 8" shaft diameters.

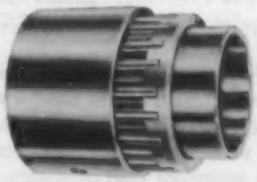


ORANGE THRUST ROLLER BEARINGS

Designed to provide maximum roller support for the load, with minimum wear. Available in designs and sizes to meet varying requirements.

ORANGE CAM FOLLOWERS

Compactly designed for high anti-friction protection under heavy load and intermittent shock. Available with standard or heavy studs, according to application.



ORANGE JOURNAL ROLLER BEARINGS

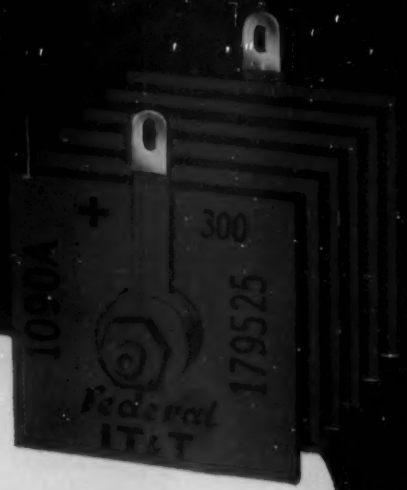
Provide high load capacity where radial space is limited, such as shafts close together or adjacent to shoulders. Available complete or component parts. Sizes ¾" to 5" shaft diameters.

ORANGE ROLLER BEARING CO., Inc.
551 Main St.
Orange, New Jersey

ORANGE

Federal

THE SELENIUM RECTIFIER
WITH THE GREATEST



Manufacturer Acceptance

More design and component engineers in the radio-TV industry have placed their approval on Federal Selenium Rectifiers than any other make—

And HERE'S why— point by point:

- **LONGER LIFE**... 5,000 hours life expectancy in approved applications.
- **HIGHER OUTPUT VOLTAGE**...3 to 6½ higher B+ output volts than competitive selenium rectifiers in conventional doubler circuits.
- **LOWER TEMPERATURE RISE**...2° C to 10° C lower average operating temperature than competitive selenium rectifiers.
- **SUPERIOR HUMIDITY RESISTANCE**... passes 1,000-hour life test in 95% relative humidity at 40° C.
- **PROVEN MECHANICAL CONSTRUCTION**... brass eyelet or aluminum stud construction used exclusively. Patented "dead-center" construction allows stack to be tightened until rigid, without affecting the pressure-sensitive selenium characteristic.
- **UNDERWRITERS LABORATORY ACCEPTANCE FOR 85° C OPERATION**... Federal's popular radio-TV types have been tested and accepted by UL for operation at cell temperatures of 85° C.
- **CONSERVATIVE RATINGS**...rectifiers offered to the industry are rated only after exhaustive temperature rise and aging tests on minimal grade units to insure full value and satisfaction.
- **MORE UNIFORM QUALITY**...Federal rectifiers are automatically 100% tested and inspected to meet standard forward and reverse current specifications, as well as for dielectric strength.
- **LARGEST PLANT CAPACITY**...production facilities to satisfy any quantity requirement.
- **MORE ENGINEERING KNOW-HOW**...the research and design facilities of the world-wide, American-owned International Telephone and Telegraph Corporation assure continued product leadership.

For full information, write Dept. F-642

Federal
A DIVISION OF I T & T

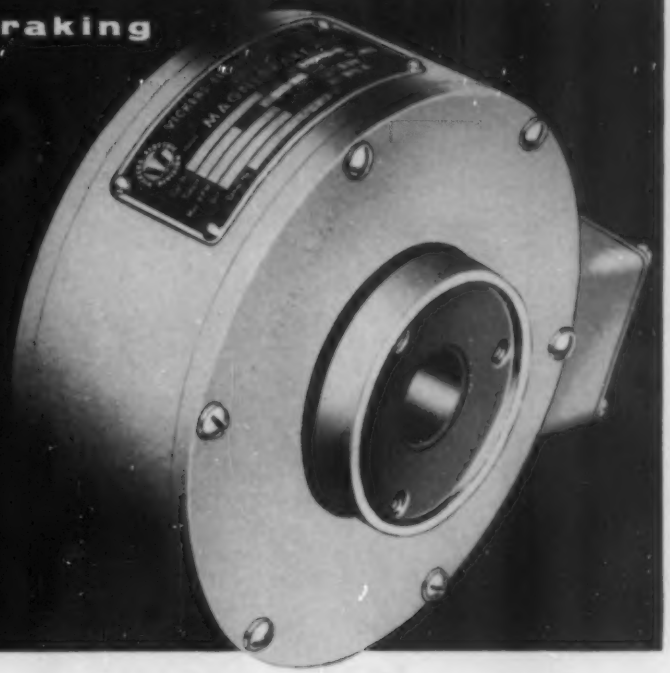
Federal Telephone and Radio Company
A Division of INTERNATIONAL TELEPHONE AND TELEGRAPH CORPORATION
COMPONENTS DIVISION • 100 KINGSLAND ROAD • CLIFTON, N. J.
In Canada: Standard Telephones and Cables Mfg. Co. (Canada) Ltd., Montreal, P. Q.
Export Distributors: International Standard Electric Corp., 67 Broad St., New York

a modern concept in braking

VICKERS®

*Magnebrake**

In 25 and 50 lb.-ft. models



a magnetic particle brake

with these outstanding advantages

- Preset or adjustable braking, from full speed to standstill, without grab, chatter or wear.
- Applied braking torque independent of speed—MAGNEBRAKE will hold a stationary load.
- Long life—no shoes or lining—no adjustment for wear required.
- Manual or automatic remote control—small control power.
- Load-holding torque equal to braking torque.
- Controllable rate of deceleration.

*(T.M.)

Write today for new Magnebrake-Magneclutch bulletin

VICKERS ELECTRIC DIVISION

VICKERS INC a unit of The Sperry Corporation

1819 LOCUST STREET • SAINT LOUIS 3, MISSOURI

Why we can supply the timer that will do your job best

Time Delay Timers

Interval Timers

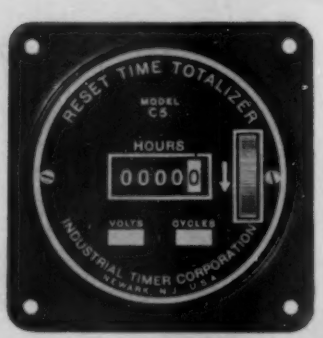
Re-Cycling Timers

To meet the widely different requirements of our customers, we work with 17 basic types, from which we have so far developed 721 combinations. 19 years of successfully "timing" these customers has equipped us with a breadth of practical experience that you can draw on. The timers we manufacture comprise a complete line in 4 broad classifications.

TIME DELAY TIMERS • INTERVAL TIMERS
RE-CYCLING TIMERS • RUNNING TIME METERS

That's why you can depend on us to meet your needs. If we can't do it with one of the 721 combinations already developed, we'll have our engineers get on it at once and develop the combination that's right for you.

Our deliveries are extra good because we maintain large stocks of our 17 basic types, and even if your order is very "special" you'll be more than satisfied with our service. Send us your specifications; you'll get a prompt reply.



Running Time Meters

Timers that Control the Pulse Beat of Industry

INDUSTRIAL TIMER CORPORATION

INDUSTRIAL TIMER CORPORATION
131 OGDEN STREET, NEWARK 4, N. J.

THE MARK OF AN EXTRA DEPENDABLE MACHINE

ED ELECTRO DYNAMIC

A BETTER KIND OF POWER PACKAGE

From America's foremost producer of custom designed motors come these premium-built, *extra dependable* E. D. "power packages" for *general industrial use*...75 years in the making... yours today *at no extra cost!*
Write for literature.

ELECTRO DYNAMIC

PRODUCT OF GENERAL DYNAMICS

GD | ED EB GA CL CV

ELECTRO DYNAMIC DIVISION OF
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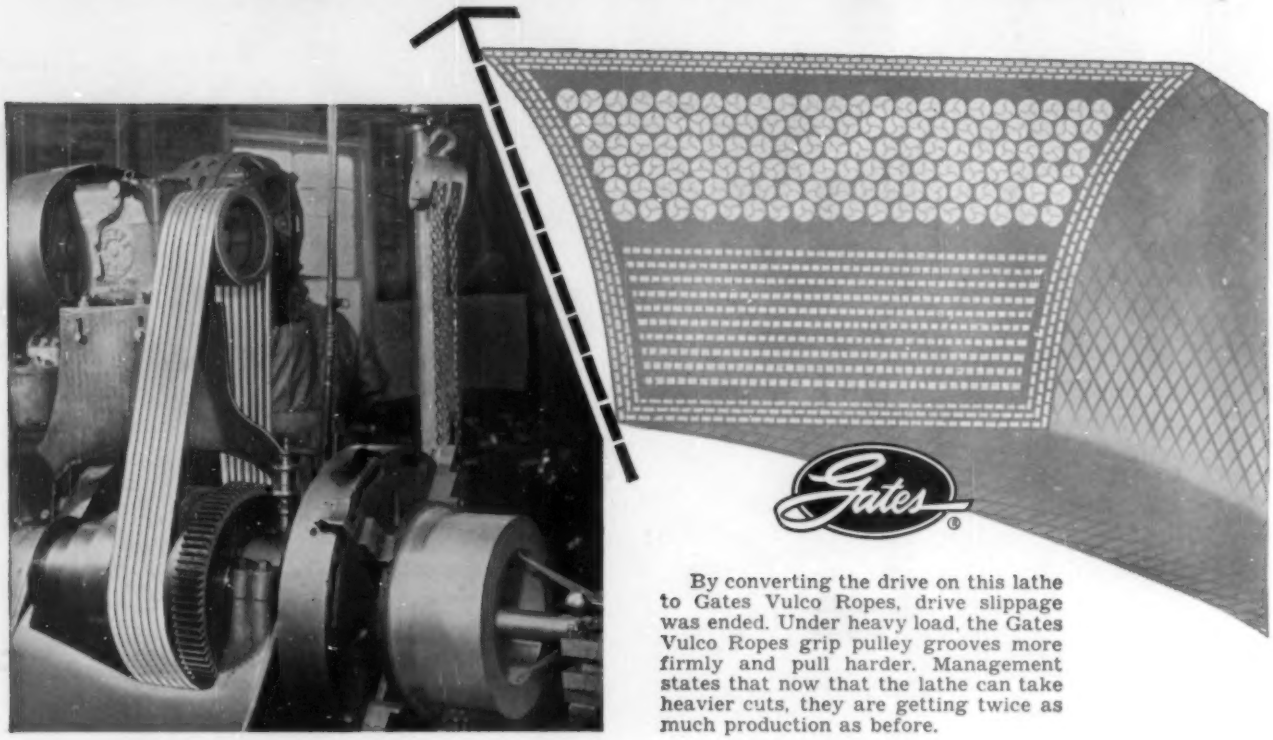
"Secret" of *lower* belt costs is concave sides



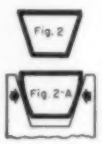
By converting the drive on this lathe to Gates Vulco Ropes, drive slippage was ended. Under heavy load, the Gates Vulco Ropes grip pulley grooves more firmly and pull harder. Management states that now that the lathe can take heavier cuts, they are getting twice as much production as before.

Plants that keep track of costs on drives know this: they get longer wear at *lower cost per year of service* when they specify Gates Vulco Ropes—the V-Belts with *concave sides.*

Here's WHY concave sides keep belt costs down:

When the Gates belt is bent around the sheave, the *precisely engineered* concave sides (Fig. 1) fill out and become straight (Fig. 1-A). Thus the belt makes uniform contact with the sides of the pulley.

This full, uniform contact assures *even distribution of wear.* Naturally, *even wear* means *longer wear.* And longer wear cuts belt replacement costs...reduces down time...contributes to profits.



Prove to yourself the value of concave sides

Bend a straight-sided belt (Fig. 2) and feel the sides *bulge out* around the bend. You see immediately that the bulging sides prevent an even fit in the pulley groove (Fig. 2-A). Uneven contact causes faster wear...increases belt replacement costs.

Reduce costs and down time for belt replacements—specify Gates Vulco Rope Drives—the V-Belt with *concave sides* (U.S. Patent 1813698). The Gates Rubber Co., Denver, Colorado—*World's Largest Maker of V-Belts.*

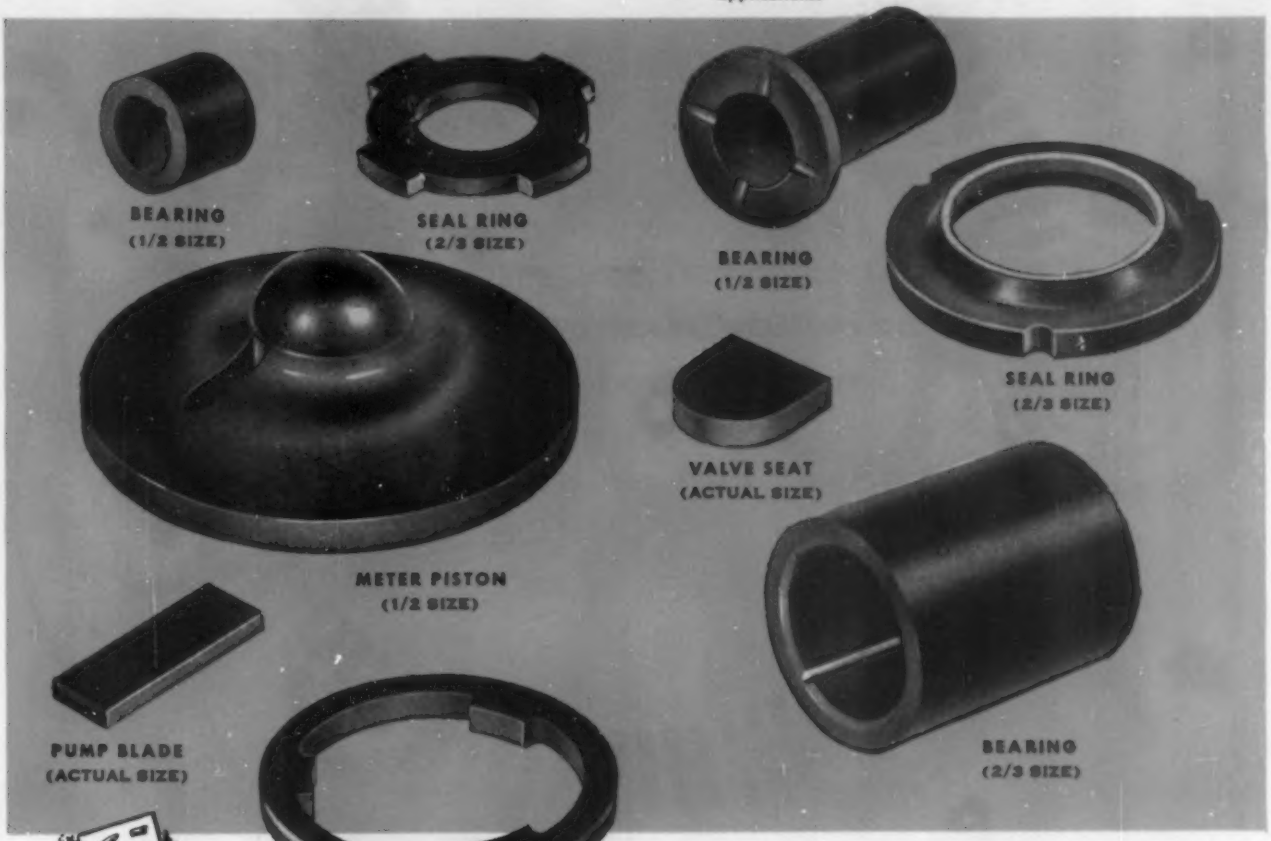
Gates Engineering Offices and Distributor Stocks are located in all industrial centers of the United States and Canada, and in 70 other countries throughout the world.

TPA 46-A

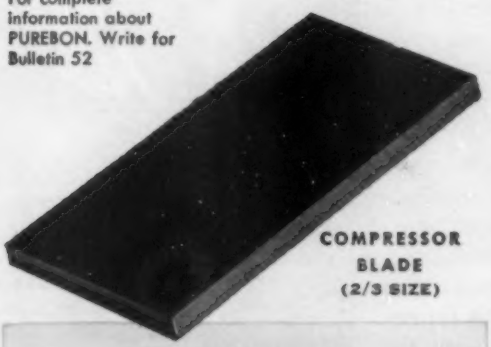
GATES VULCO ROPE DRIVES

. . . the solution to your Lubrication problem is here . . . PUREBON

Carbon-graphite especially designed for mechanical applications.



For complete information about PUREBON. Write for Bulletin 52



PURE CARBON CO., INC.
448 HALL AVENUE
ST. MARYS, PENNSYLVANIA

Purebon is the designer's solution to many knotty problems involving sliding or rotating parts where lubrication is difficult and sometimes impossible. Purebon parts are molded or machined exactly to our customers' specifications here in our own plant, under our close supervision and inspection. *Because of the diversified characteristics of Purebon, applications are limited only by the designer's imagination.* If you have a problem involving insufficient lubrication at critical points of friction, our design engineering department will be happy to work with you toward its swift and successful solution.

PUREBON'S PROPERTIES

1 ***MOLDED TO SIZE—FOR MANY APPLICATIONS***
Tolerances of approximately 1½% of dimension required for molding most shapes.

2 ***SELF-LUBRICATING—OR BY THE MATERIAL HANDLED***
Varies with grade of Purebon.

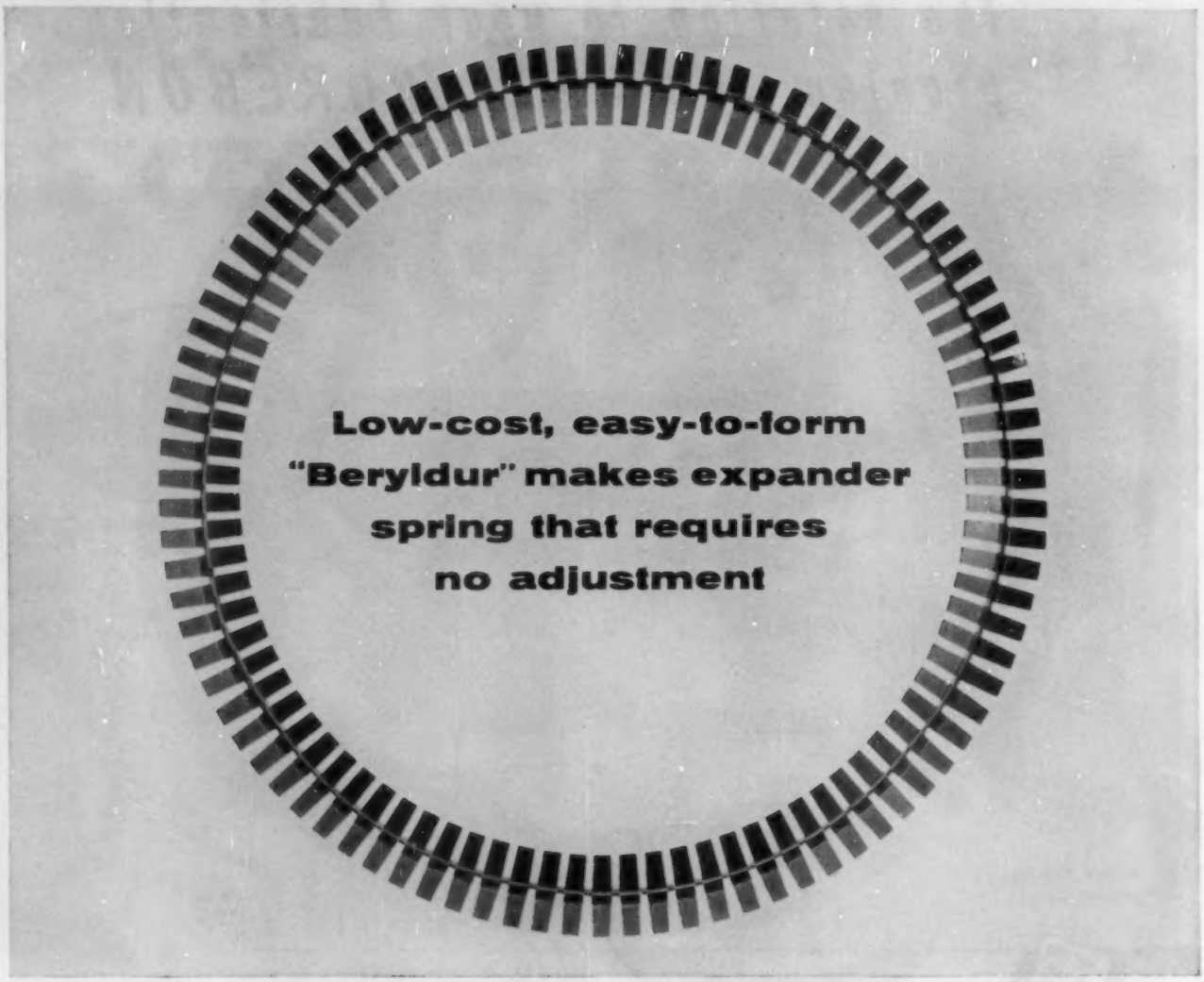
3 ***STRONG AND TOUGH***
Transverse strength varies from 4,000 to 13,000 lb./sq. in. according to grade.

4 ***READILY MACHINABLE***
Tolerances as close as .0005 can be maintained where required.

5 ***CHEMICALLY INERT—NON-TOXIC***
Resistant to attack by chemicals of all kinds, used in food handling and processing equipment.

6 ***HIGH TEMPERATURE APPLICATION***
Most Purebon grades will operate efficiently in temperatures up to 700°F in air or much higher in neutral or reducing atmosphere.

Leaders for over 40 YEARS in PURE CARBON PRODUCTS



This finger spring is a U packing expander which maintains a seal at 0-5 pounds in the cylinder of a hoist.* What are the characteristics demanded in an application of this kind? First, corrosion resistance. "Beryldur," like all beryllium copper alloys, is highly corrosion resistant. Second, uniform spring pressure. If the expander is too loose, the packing will leak oil and water. If it is too tight, it will prevent the plunger from moving freely. It is enough to say on this point that this "Beryldur" expander never needs field adjustment.

Finally, formability is all-important. The 130° bends parallel to the rolling direction around a 1/16" radius could cause trouble—but in "Beryldur," grain direction is uniform and blanking is no problem. The expander was originally made of 12 6-in. sections riveted together; now it is made of two strips of mill-hardened "Beryldur."

The properties of "Beryldur" are midway between those of high-strength and high-conductivity "Berylco" Beryllium Copper alloys. "Beryldur" therefore has a higher tensile strength than brass or bronze, plus high fatigue strength, great resistance to wear, and good electrical conductivity. For sample material or engineering help, call or write any of the offices listed below.

"BERYLDUR" EXPANDER is pushed down over plunger, then U packing is forced over the expander.

FURTHER INFORMATION about "Beryldur" is contained in this 4-page folder. Send for your free copy today.

BERYLCO ®

*Made by Globe Hoist Co., Des Moines, Iowa, Philadelphia, Pa.

THE BERYLLIUM CORPORATION

DEPT. 5F • READING 2, PENNA.

New York • Springfield, Mass. • Rochester, N. Y. • Philadelphia • Pittsburgh • Cleveland • Dayton • Detroit • Chicago • Minneapolis • Houston • San Francisco • Los Angeles

Representatives in principal world-trade centers

much more than a common carrier... JEFFREY HOLLOW-PIN chain

You are not just looking at the "hole in the doughnut." Functional use of Jeffrey Hollow Pin Chain has many applications. In the baking industry, for instance, this chain makes it easy to attach trays and other fixtures to be conveyed. Supporting rods are simply inserted in the pins. The chain runs on rollers; gives smooth operation and firm support.

Jeffrey offers a full line of Hollow Pin Chain in a variety of pitches to suit your particular spacing requirements. Pin and bushings are hardened and ground for smooth, tough wearing surfaces. Sidebars and rollers are heat-treated to specifications for your application.

To improve the quality and performance of your equipment, let Jeffrey engineers help you determine the right chain or other component parts.

Jeffrey Hollow Pin Chain takes trays of bread on a smoothly-timed trip through bakery oven.

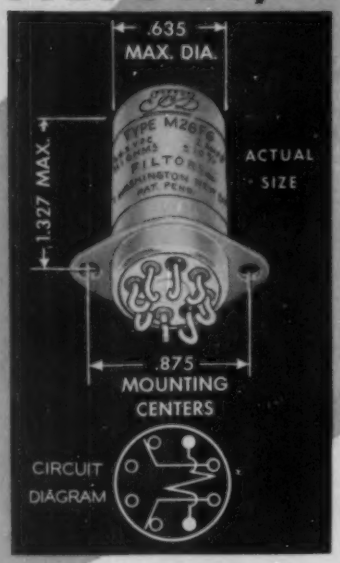
JEFFREY O.E.M. EQUIPMENT

STR Drive and Conveyor Chains
Combination and Knuckle Chains
Steel Carve and Cast Sprockets
Spiral Conveyors
Buckets
Pulleys
Slatted Pulleys
Belt Idlers
Pillow Blocks
Set Collars
Couplings
Draw Bench Chains

THE JEFFREY MANUFACTURING CO.
ESTABLISHED 1877
Columbus 16, Ohio
sales offices and distributors in principal cities
PLANTS IN CANADA, ENGLAND, SOUTH AFRICA

IF IT'S MINED, PROCESSED OR MOVED
. . .IT'S A JOB FOR JEFFREY!

NEW DPDT
SUB-MINIATURE RELAY
by
FILTORS, INC.



ENGINEERED FOR CRITICAL AIRBORNE AND GUIDED MISSILE APPLICATIONS

This Relay Meets the Requirements of

MIL-R-5757B and MIL-R-25018 (USAF).

Two Form C contacts are rated at 2 amps, resistive, at 29 V.D.C. or 115 V.A.C.

Withstands operational shock of 50 G's and operational vibration of 5 to 2000 CPS at 10 G.

AMBIENT TEMPERATURE RANGE: –60°C to +125°C

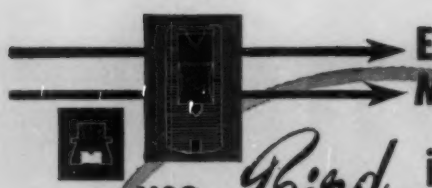
WEIGHT: 1.3 ounces

OPERATE TIME: 10 milliseconds or less.

RELEASE TIME: 5 milliseconds or less.

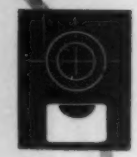
Send for NEW CATALOG

FILTORS, Inc. P
30 Sagamore Hill Dr., Port Washington, L. I.
PLEASE SEND RELAY CATALOG
NAME .....
COMPANY ..... TITLE .....
CITY ..... STATE .....

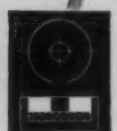


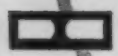
ELIMINATE REJECTS! MINIMIZE BREAKAGE!

use *Bird* jewel assemblies



Why chance rejects and breakage that add to production costs when you can eliminate these time-wasting "headaches" with Bird complete jewel assemblies — ready to install in your equipment. Bird's many years of precision production mean jewel bearings of the highest quality. These jewels are set according to your specifications by skilled craftsmen, in less time, for less money, and eliminate special set-ups in your plant.





Why not bring us your jewel problems — you specify — Bird will supply assemblies that fit your product and schedule. Our engineering staff is at your service for all your jewel bearing problems.

For information on jewel assemblies write for Bulletin 14.

Over 40 years of serving industry with Quality jewel bearings

Richard H. Bird & Co., Inc.

Sapphire and glass jewels · Precision glass grinding · Ferrite precision products · Sapphire styli

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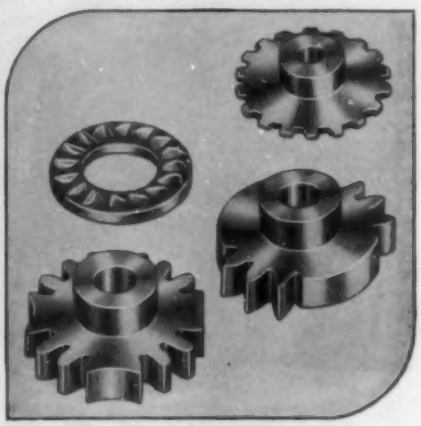
Delays in personal service are annoying, but delays in deliveries can cause substantial losses in production and sales.

You can avoid these costly delays by specifying Mass Gears.

Prompt and attractive quotations can be obtained by sending your prints to Mass Gear.



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Air Operation to 250 psi, Hydraulic Operation to 750 psi
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Air or Hydraulic Operation to 110 psi
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Here's Everything You Need
Smooth, Dependable Power
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■ "Good things come in small packages," it is said . . . so do Hanna Cylinders . . . and in medium and large packages, too. From the complete Hanna Cylinder line, up to 1,500 psi capacities, you can selcct a standard size and mounting style, with the power and stroke you need, to exactly suit your applications. Of course, you will be sure it's the finest cylinder for the job—because it's a Hanna. Well over fifty years of design and manufacturing experience guarantee that.

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Hanna Engineering Works
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Flexible Shafts meet the toughest performance standards

In rugged construction equipment, S.S.WHITE FLEXIBLE SHAFTS give reliable, day-in, day-out service

S.S.White flexible shafts (arrows) transmit power from electric motors to the vibrating heads of this multiple concrete vibrator. Used to compact stiff concrete mixes in highway and airport runway construction, this machine puts a premium on performance — a test which S.S.White flexible shafts pass with flying colors. Where dependability counts, you can always rely on an S.S.White flexible shaft because it's performance-proved for any application, large or small.

If you have a problem involving the transmission of rotary power or remote control it will pay you to contact S.S.White FIRST. Engineering cooperation is always available. There's no obligation.

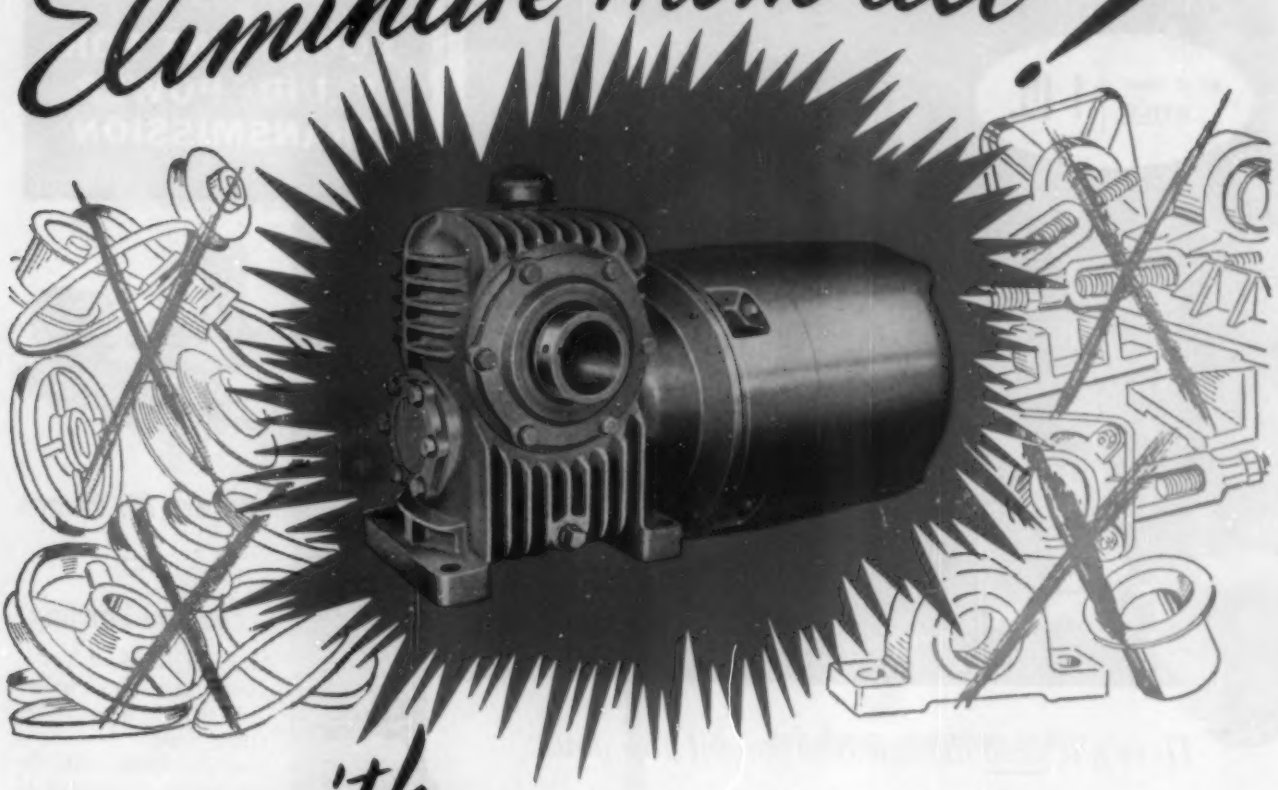
Flexible shaft information for you...
Bulletin 5306 has basic information and data on flexible shaft selection and application. Send for a copy. Address Dept. D.

S.S.WHITE INDUSTRIAL DIVISION 10 East 40th Street, New York 16, N. Y.

S.S.White FIRST NAME IN FLEXIBLE SHAFTS

F-6

Eliminate them all!



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MOTORIZED CONE-DRIVE SHAFT MOUNTED SPEED REDUCERS

Get rid of all those components usually required with shaft mounted speed reducers in one simple step. Simply design with double-enveloping worm gear Cone-Drive speed reducers. Reducer, bearings and motor are all combined in a single compact unit. No belts to wear out and replace. No bed plates, pulleys, or sheaves to align and adjust. No torque arm either; just mount reducer directly to base of machine. Inventories will be simplified, too, when you stock Cone-Drive reducers.

That's not all you get with Cone-Drive shaft mounted reducers! You get double-enveloping worm gearing—the most efficient method of right-angle power transmission available today. Cone-Drive gears almost half the size still carry the same load as cylindrical worm gearing.

You get the smoothest power delivery possible with Cone-Drive gears—ideal for all kinds of rolling, calendering and similar types of machinery. And, they'll require a minimum of maintenance because the double-enveloping design spreads tooth loads over a greater area, reducing wear and lengthening life.

Inspect your present or proposed drive system now. See how Cone-Drive shaft mounted reducers can make it smaller, more efficient and most important, more saleable.

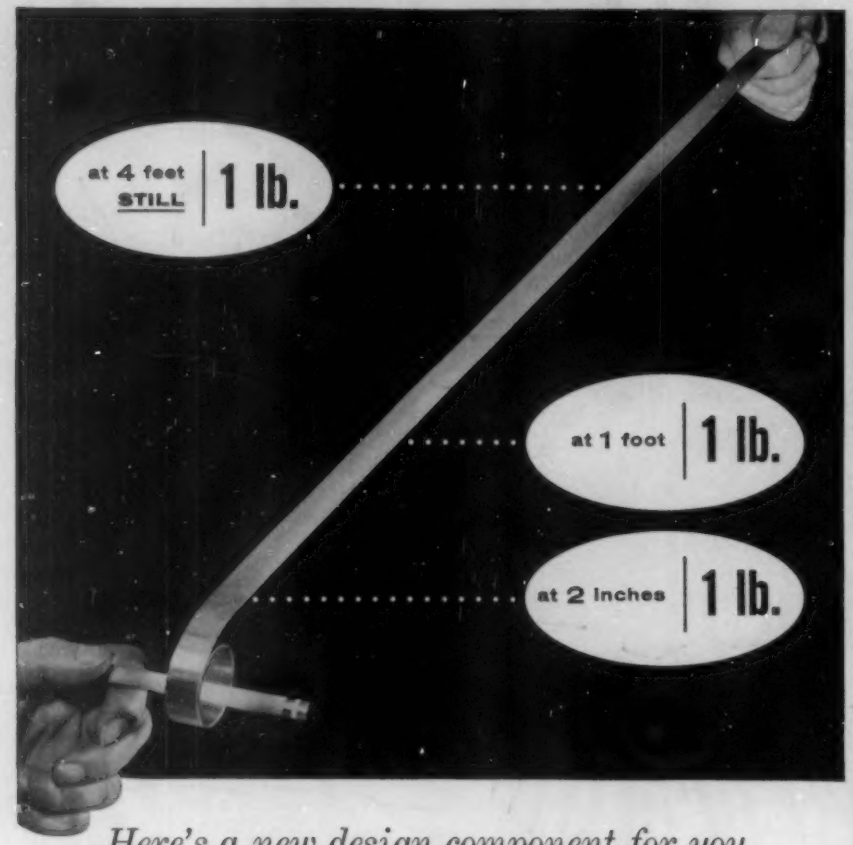
Bulletin CD-323 will show you how to provide greater flexibility in the design of your equipment. Ask for it.

CONE-DRIVE GEARS

DOUBLE ENVELOPING GEAR SETS & SPEED REDUCERS

Division, Michigan Tool Company

7171 E. McNichols Road • Detroit 12, Michigan



Here's a new design component for you

THE FIRST CONSTANT FORCE SPRING!

Do *you*, too, want to simplify a product design problem — reduce weight, miniaturize, cut cost, *improve* the product, or even create a *new* product?

Can you use a *constant force spring* that's *not only a spring* but also a *motor*, a *counterbalance*, a *clamp*, *clip*, *slot closure*, and anything else *you* might make it?

The Hunter Neg'ator *constant force* spring upsets all previous spring principles. In addition to a zero gradient, negative or slightly positive gradients are also possible with the Neg'ator.

Hundreds of ingenious engineers have already used the Neg'ator spring to obtain—

- Tremendous extensions—over 30 times the original size—with no appreciable force build-up.
- Driving torques with longer duration and *no* heavy wind-up.
- Full force available from the very beginning of the stroke right up to the completion of the return stroke.
- The equivalent of a dead weight (in a range sufficient to counterbalance a mouse or a man) in one handful.
- Many other unusual characteristics.

Are *you* ready to learn more about this remarkable new spring element? We're ready to tell you. Just ask for our new bulletin, "The Hunter Neg'ator Spring". This bulletin describes the Neg'ator force characteristics, and its variety of forms and applications. Also included are many "thought provokers" for applying this promising new mechanical element.

THE HUNTER
neg'ator
constant force spring

HUNTER SPRING COMPANY

Lansdale, Pennsylvania . . . near Philadelphia

SPRINGS • STAMPINGS • TEST APPARATUS

KRAISSL

Since 1926, in the application, design and manufacture—pumps, separators, hydraulic accessories

EQUIPMENT FOR FLUID POWER TRANSMISSION

Primary

Oil Pumps

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Pressure

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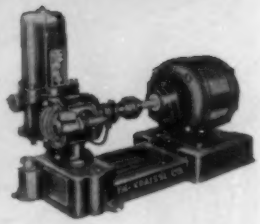


Rotary Air Pumps for vacuum bottling

Kraissl's patented, automatic, force-free lubrication and flushing system makes these direct - drive, high-capacity pumps ideal for the special requirements of bottle-filling machinery.

Air - cooled design — or water - cooled models for heavier duty.

Class 21-roller-action pumps are recommended for handling corrosive gases and extraneous matter that might jam with closer clearances. The multi-blade design of the Class 25 pumps gives higher capacity efficiencies and is designed for applications requiring higher degree of vacuum. Where water - cooling is desired for continuous service, the water-jacketed Class 25-WJ models are recommended.

EXCLUSIVE CLASS 26 AIR FILTER

is available as an integral part of each pump up to 10 cfm — to produce oil-free discharge air and also conserve the lubricating oil.

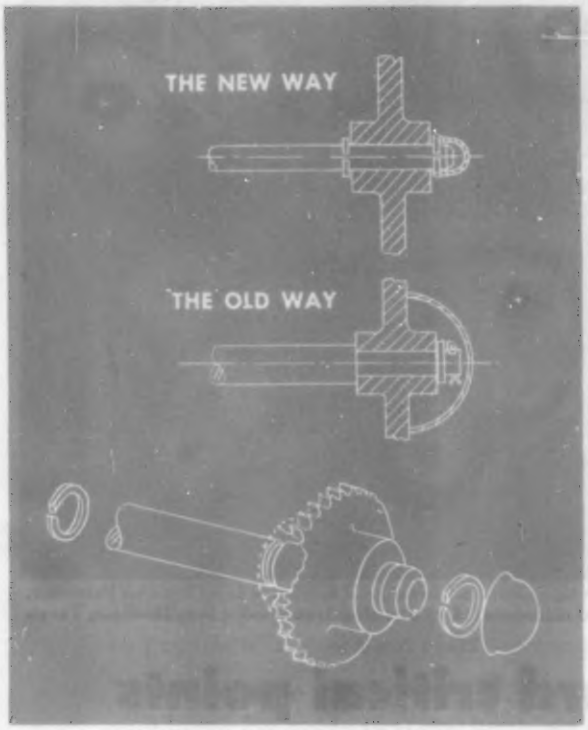
Write today for Bulletins A-1289 and A-1523

KRAISSL KRAISSL CO

289 Williams Ave., Hackensack, N. J.

"SAVE TIME— SAVE MATERIALS— SAVE MONEY"

will always be a great industrial slogan



Simple little retaining rings...

1. **shorten assembly time**
2. **reduce maintenance of parts**
3. **reduce weight**
4. **cut down needless space**
5. **save material**
6. ***increase ultimate profit*** **— and frequently *improve* his product at the same time.**

The world admires not only our unparalleled mass production, but our ingenious designing and *redesigning* which constantly improve and simplify *without* sacrificing strength and complete dependability.

Practically every manufacturer can improve his product—and his ultimate profit—by redesigning his machines and the construction details of his products.

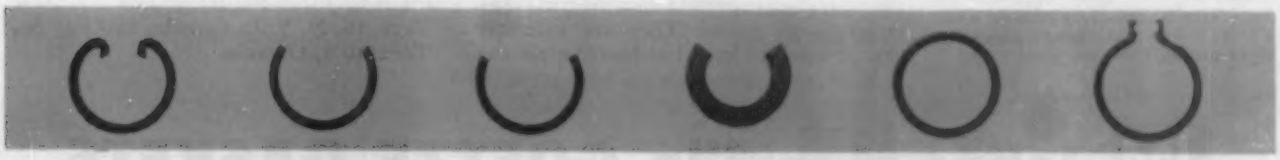
The use of these inexpensive yet efficient artificial shoulders is already widespread—and is increasing constantly.

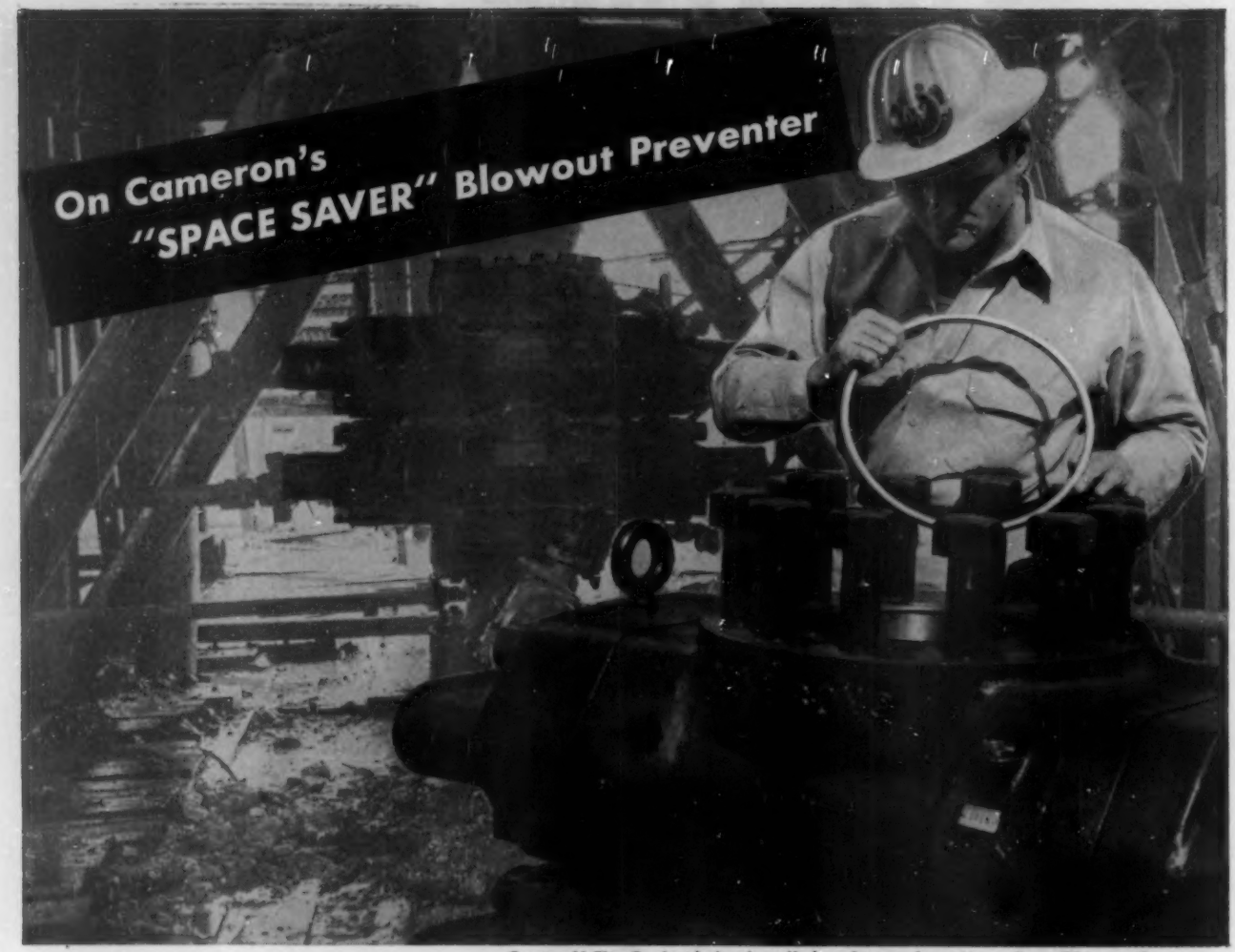
Every product—metal, wooden or plastic—should be examined carefully to see where shoulders and collars could be redesigned to use these steel rings.

Write today for descriptive booklet.

THE NATIONAL LOCK WASHER CO.

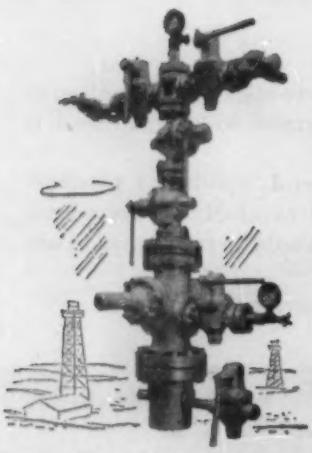
NEWARK 5, NEW JERSEY • MILWAUKEE 2, WISCONSIN, U. S. A.





Goetze V-Tite Gasket being installed on flange of new Space Saver Blowout Preventer, designed and manufactured by Cameron Iron Works, Inc., Houston, Texas.

Goetze Gaskets safeguard critical points under severe pressures



Christmas Tree made by Cameron Iron Works, Inc., is equipped with Goetze V-Tite gaskets to provide safe, tight sealing for every joint.

The new "Space Saver" Blowout Preventer made by Cameron Iron Works, Inc., of Houston, Texas, weighs only half as much as earlier equipment and takes only one-half the space. This improved design permits rig platforms to be smaller, makes possible savings on handling and materials.

For this new equipment Cameron chose Goetze V-Tite Gaskets to do the critical job of sealing Ring-Joint flanges. These precision-made gaskets withstand the high pressures encountered in oil and gas production. Goetze V-Tite Gaskets are fabricated to extremely close tolerances to secure perfect matching of rings with flange joints. They are carefully heat-treated to keep hardness below the maximum allowable. This assures proper flow of the gasket without damage to flange surfaces and reduces the necessity for undue bolt stresses.

Both standard cross-sectional shapes, the oval (Style 950) and octagonal (Style 951), seal tightly at low bolt stresses. Made to ASA-API standards, they are supplied in metals and alloys offering maximum resistance to service and temperature conditions. In addition to the ASA-API sizes, special sizes ranging from one inch to seven feet pitch diameter are available. Catalog PK-35A gives details, sizes and engineering data. Write for it to Johns-Manville, Box 60, New York 16, N. Y. In Canada, 199 Bay St., Toronto 1, Ontario.

JOHNS-MANVILLE JM PRODUCTS

Johns-Manville GOETZE GASKETS

Which is the CleCap?

...the unusually LARGE one that's hard to find

One of the advantages CleCap customers enjoy is the knowledge that when they want some of those BIG cap screws, the chances are 9 out of 10 we can ship them the same day.

CleCap makes 'em regularly from ¼" to 2½" diameters, any length you want—ferrous and non-ferrous—and we stock a lot of unusual sizes, nearly 10,000 different items last count.

That's another reason for dealing with *The* cap screw specialists of the country. You also get unbeatable top-quality fasteners . . . PLUS a CleCap crew that has a long-made rep for "busting a leg" to get you what you want exactly when you want it.

What happens to your profits when late deliveries hold up production lines? Put your cap screw needs up to CleCap . . . and relax!

The Cleveland Cap Screw Co.
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VU Ican 3-3700 TWX CV42

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CLEVELAND *Top Quality* FASTENERS

Ferrous and Non-Ferrous: Bright, High Carbon and Alloy Steel Heat Treated, Brass, Silicon Bronze, Stainless Steel

Hex Head Cap Screws: ¼" to 2½" dia.
Socket Head Cap and Set Screws—Plain and Knurled: ¼" to 1½" dia. Also Flat and Button Head Styles.
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Fillister Head: ¼" to 1" dia.
Set Screws—Square Head: ¼" to 1½" dia.
Milled Studs: ¼" to 1¼" dia.
Place Bolts: ¼" to 1¼" dia.
Structural Bolts to ASTM Specification A325
Tractor Bolts
Special Hot and Cold Headed Parts

Facilities to make larger diameters than listed.

Ask your jobber for CleCap!

Originators of the Kaufman DOUBLE EXTRUSION Process

7/8"

never before...
a potentiometer
the size of a penny
yet worth a fortune
in performance!

DeJUR Series C-078

SUBMINIATURE POTENTIOMETERS

Now – the features of full-size potentiometers in a new series that's no larger than a penny! If your product is for computers, trimmers, guided missiles, or any portable or aircraft equipment, DeJUR's new subminiature potentiometers help you achieve substantial savings in weight and space.

- Unit height only ⅝", weight only ½ oz.
- Single or multiple gangs
- Independently phased
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- 320° electrical and 326° mechanical rotation
- Gold collector for trouble-free contacts
- Multiple-finger precious metal contact brush
- Available with special torque ratings, ball-bearings, sealed housings, special tolerances and other requirements for any linear or non-linear function.

WRITE FOR COMPLETE TECHNICAL LITERATURE. *No obligation. Our engineering department can supply prototypes to meet unusual design specifications for tests and approval. Send us your specs for analysis.*

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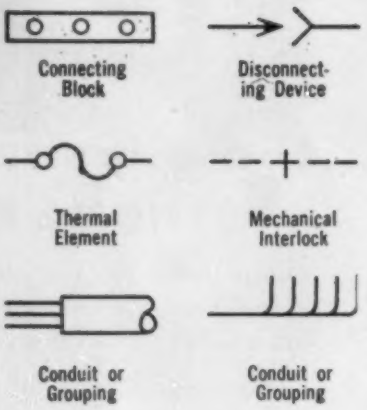

Now you can help achieve industry-wide agreement on graphical symbols for electrical components. As you know, different groups have in the past advanced various proposals for standardization. But while many suggestions had merit, often forgotten was the fact that the symbols must be simple.

For this reason we have collected and reprinted, in an easy-to-use folder, the simplest-to-draw and most readily understandable symbols available. They are based mainly on the Engineering Drafting Standards of the Ford Motor Company, and are supplemented by standards data from the American Standards Association and from the National Machine Tool Builders Association.

To order a supply of these folders for you and your associates, write or call our Reader Service Department today. Copies are only 15¢ each.

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Controlled compressed air has given Industry muscle-saving power to produce more . . . economically . . . without fatigue . . . more safely.

Compressed air has become a must in every plant. If you are not now using it, investigate it. And—wherever you actually use compressed air—you'll make its use more effective if you use the best valves possible—Schrader Valves. They are designed and built by a company whose success dates back to 1844—more than a century of experience in air control.

In the complete line of Schrader Valves you'll find two-, three- and four-way models . . . for hand, foot, cam, pilot or solenoid operation . . . for practically any application.

Find out how Schrader Valves can put compressed air to work to save you money. For specification data, write—or, if you prefer, fill out the coupon below.

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REG. U. S. PAT. OFF.

LEADERS IN AIR CONTROL SINCE 1844

The complete Schrader line of pneumatic accessories includes everything you need

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Division of Scovill Manufacturing Company, Incorporated
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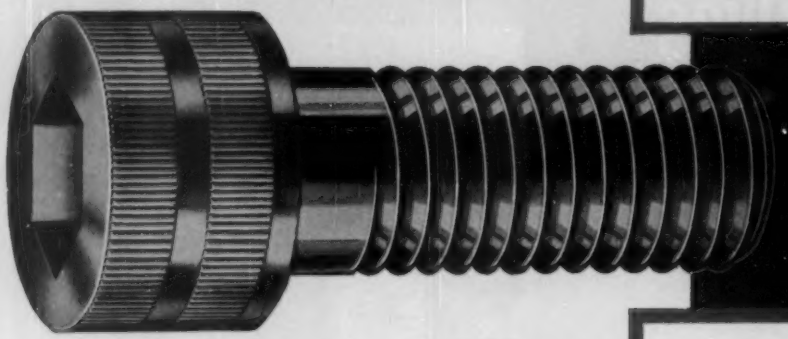
I am interested in more information on _____

Name _____ Title _____

Company _____

Address _____

NO GADGETS-
NO GIMMICKS



SET SCREWS
For safety and high holding power.

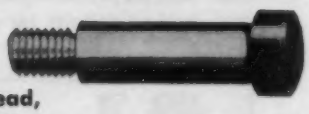
BUTTON HEADS
Where countersinking is impractical.

CAP SCREWS
For high strength and compact design.

FLAT HEADS
For a smooth, unobstructed surface.

PIPE PLUGS
Precision threads for the tightest fit.

STRIPPER BOLTS
For concentric head, shoulder and thread.



DOWEL PINS
Special finish is corrosion-resistant, facilitates driving.

Holo-Krome Concentrates On Making Tough, Precision Socket Screws!

We offer the strongest, simplest, most accurate socket screws we can make!

For greatest strength and accuracy, we *completely* cold-forge the finest alloy steel. For maximum locking action, we thread to a Class 3 Fit.

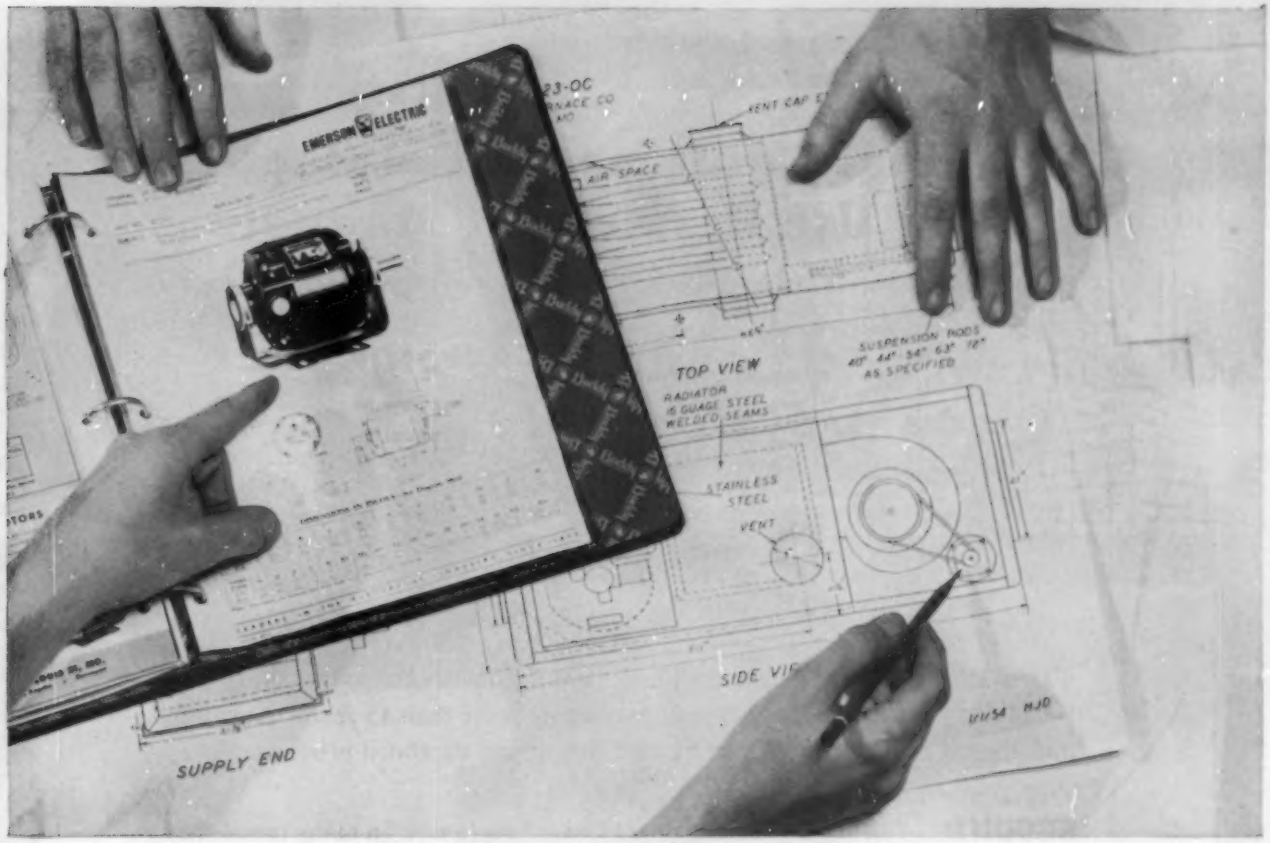
When a socket screw is so carefully made . . . *it doesn't need any fancy "gadgets"!*

For the finest in socket screws . . . for SAME-DAY SERVICE ON STANDARD PRODUCTS . . . for cost-cutting packaging—the name to remember is HOLO-KROME!

Available from authorized Holo-Krome Distributors

HOLO-KROME

THE HOLO-KROME SCREW CORP. HARTFORD 10, CONN.



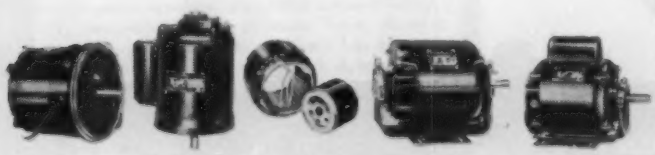
AN EMERSON-ELECTRIC MOTOR-DRIVE SPECIALIST PROVIDES "ON-THE-SPOT" HELP FOR YOU

The biggest plus value any appliance or equipment manufacturer can get from Emerson-Electric is the benefit of 65 years of specialized experience in power drives.

Emerson-Electric specialists will start at the beginning, or idea stage, of your problem—will stay with it through every phase of development and application—will work closely with your engineers on any improvement program you have in mind... Their services are available *right now*—at Emerson-Electric you don't have to stand in line and wait your turn, because every customer is a most valuable asset.

Profit by Emerson-Electric's years of experience and the combined ability of its motor specialists. They know motors AND their application. They can save you time and money.

Emerson-Electric supplies motors for appliances and equipment principally in these classifications: Oil Burner Blowers • Unit Heaters • Water Circulators • Air Conditioning • Washers Driers • Ironers • Garbage Disposers Refrigerators • Freezers • Water Pumps • Air Compressors



For Oil Burners | For Pumps | Hermetic Motor Parts | For Laundry Equipment | For Blowers

Emerson-Electric
of St. Louis • Since 1890

Write THE EMERSON ELECTRIC MFG. CO., ST. LOUIS 21, MO., for bulletins listed below.

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- ☐ M 4011-B Split-Phase
- ☐ M 4011-C Integral
- ☐ M 4011-D Fan Duty
- ☐ M 4011-E Oil Burner
- ☐ M 4011-F Jet Pump
- ☐ M 4011-G Blower

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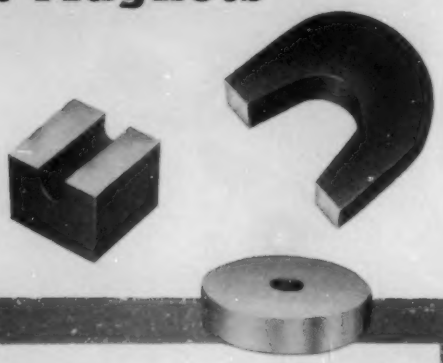
a message

to Original Equipment Manufacturers Who Use Permanent Magnets

May we have 1 minute and 2 seconds to tell you why Indiana Steel Products Company can do the best job, and the most thorough job, of supplying your permanent magnet requirements?

HERE ARE 5 REASONS:



FIRST . . . we're specialists. Indiana Steel Products Company has concentrated on manufacturing permanent magnets for more than 45 years! Attention and interest are not spread over many different and unrelated products.

SECOND . . . all Indiana salesmen are trained *engineers*. In many cases, they can give on-the-spot assistance with immediate problems . . . no delay while they check with the home office.

THIRD . . . Indiana sales engineers draw on our company's 45 years' experience in designing and producing permanent magnets for every conceivable type of application. More often than not, he has *already* encountered problems similar to yours.

FOURTH . . . competently staffed local offices, with direct communication with the home office, assure you of the best possible service . . . expedite rush and emergency deliveries, when necessary.

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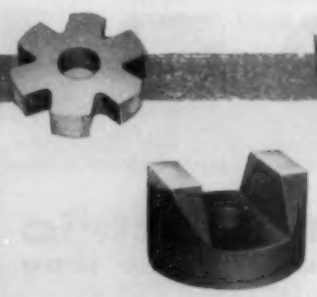

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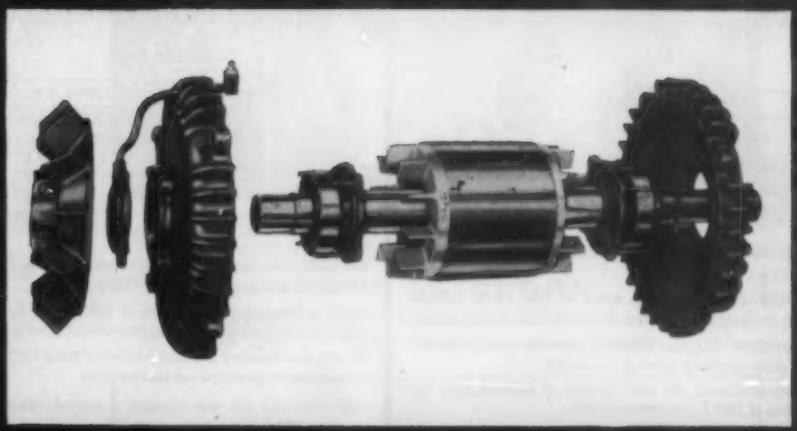

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TYPE QDB

Gerotor's NEW QDB series of small capacity pumps . . . the last word in precision engineering.

DELIVERY G.P.M. — 1800 R.P.M.					
TYPE	DISCHARGE PRESSURE P.S.I.				
	0	250	500	750	1000
QDB .4	.42	.40	.38	.35	.31
QDB .75	.84	.80	.78	.73	.66
QDB 1.5	1.67	1.62	1.57	1.50	1.42

Selection Data

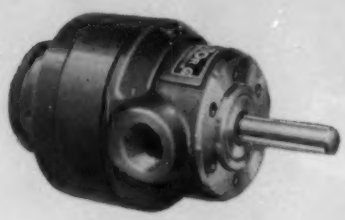
HORSEPOWER REQUIRED — 1800 R.P.M.					
TYPE	DISCHARGE PRESSURE P.S.I.				
	0	250	500	750	1000
QDB .4	.08	.16	.24	.33	.41
QDB .75	.13	.27	.41	.56	.71
QDB 1.5	.16	.42	.70	1.00	1.28

PRESSURE—Maximum continuous operating pressure is 1000 p.s.i.

SPEED—Standard design speed is 1800 r.p.m. Specific recommendations are made for applications at other speeds.

ROTATION—Standard rotation is clockwise facing shaft end. Counter-clockwise rotation is available.

OIL—Hydraulic oils with viscosity of approximately 300 s.s.u. at 100° F. are recommended.



TYPE QDH

The QDH . . . popular intermediate size of the Gerotor line

DELIVERY — G.P.M. AT 1200 R.P.M.							
TYPE	DISCHARGE PRESSURE P.S.I.						
	0	250	500	750	1000	1200	1500
QDH 3	3.3	3.2	3.1	3.0	2.9	2.7	2.5
QDH 5	5.6	5.4	5.3	5.2	5.1	4.8	4.4
QDH 8	8.6	8.5	8.4	8.3	8.2	8.1	7.8
QDH 12	12.9	12.8	12.7	12.5	12.3	12.2	11.8

Selection Data

HORSEPOWER REQUIRED AT 1200 R.P.M.							
TYPE	DISCHARGE PRESSURE P.S.I.						
	0	250	500	750	1000	1200	1500
QDH 3	.25	.7	1.2	1.6	2.1	2.5	3.4
QDH 5	.33	1.1	1.8	2.5	3.2	3.7	4.6
QDH 8	.4	1.5	2.7	4.2	5.4	6.3	7.9
QDH 12	.5	2.3	4.2	6.1	8.0	9.6	11.7

PRESSURE—Maximum continuous operating pressure is 1200 p.s.i., maximum intermittent 1500 p.s.i.

SPEED—Standard design speed is 1200 r.p.m. Specific recommendations are made for applications at other speeds.

ROTATION—Standard rotation is clockwise facing shaft end. Counter-clockwise rotation is also available.

OIL—Hydraulic oils with viscosity of approximately 300 s.s.u. at 100° F. are recommended.

TYPE O

Gerotor Series O . . . when larger capacities are needed

DELIVERY — G.P.M. AT 1200 R.P.M.					
TYPE	DISCHARGE PRESSURE P.S.I.				
	0	250	500	750	1000
O-20	20.0	19.5	18.8	18.0	17.2
O-25	25.0	24.5	24.0	23.2	22.2
O-30	31.2	31.0	30.5	29.8	29.0
O-40	43.0	42.5	42.0	41.5	40.0

Selection Data

HORSEPOWER REQUIRED AT 1200 R.P.M.					
TYPE	DISCHARGE PRESSURE P.S.I.				
	0	250	500	750	1000
O-20	1.0	4.0	7.2	10.5	13.5
O-25	1.5	5.0	8.6	12.0	15.6
O-30	2.0	6.5	10.9	15.5	19.5
O-40	3.0	9.0	15.0	21.0	27.5

PRESSURE—Maximum continuous operating pressure is 1000 p.s.i., except type O-40, which is recommended for only intermittent duty at 1000 p.s.i.

SPEED—Standard design speed is 1200 r.p.m. Specific recommendations are made for applications at other speeds.

ROTATION—Standard rotation is clockwise facing shaft end. Counter-clockwise rotation is available.

OIL—Hydraulic oils with viscosity of approximately 300 s.s.u. at 100° F. are recommended.

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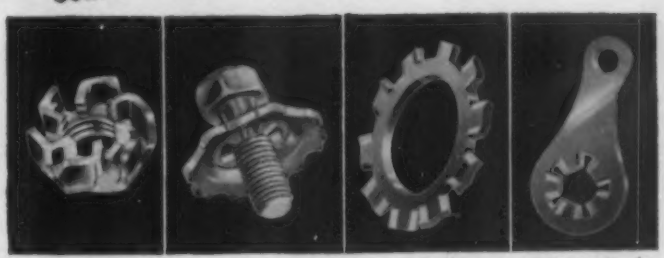

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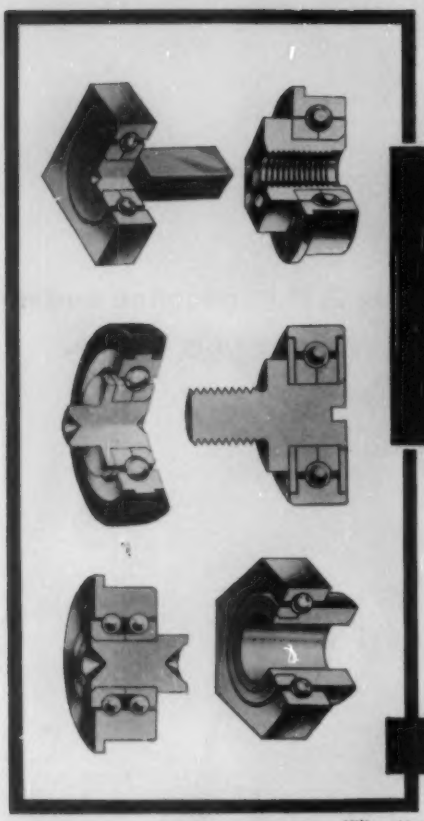

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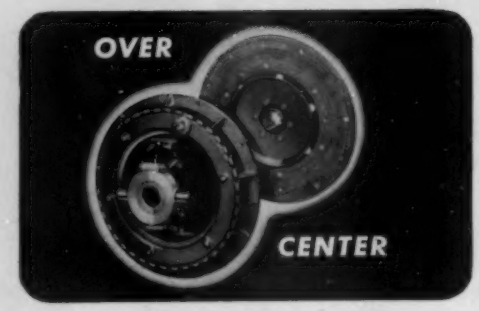

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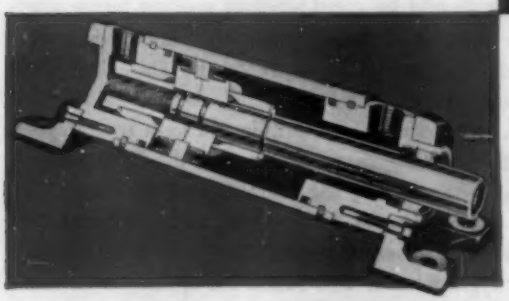

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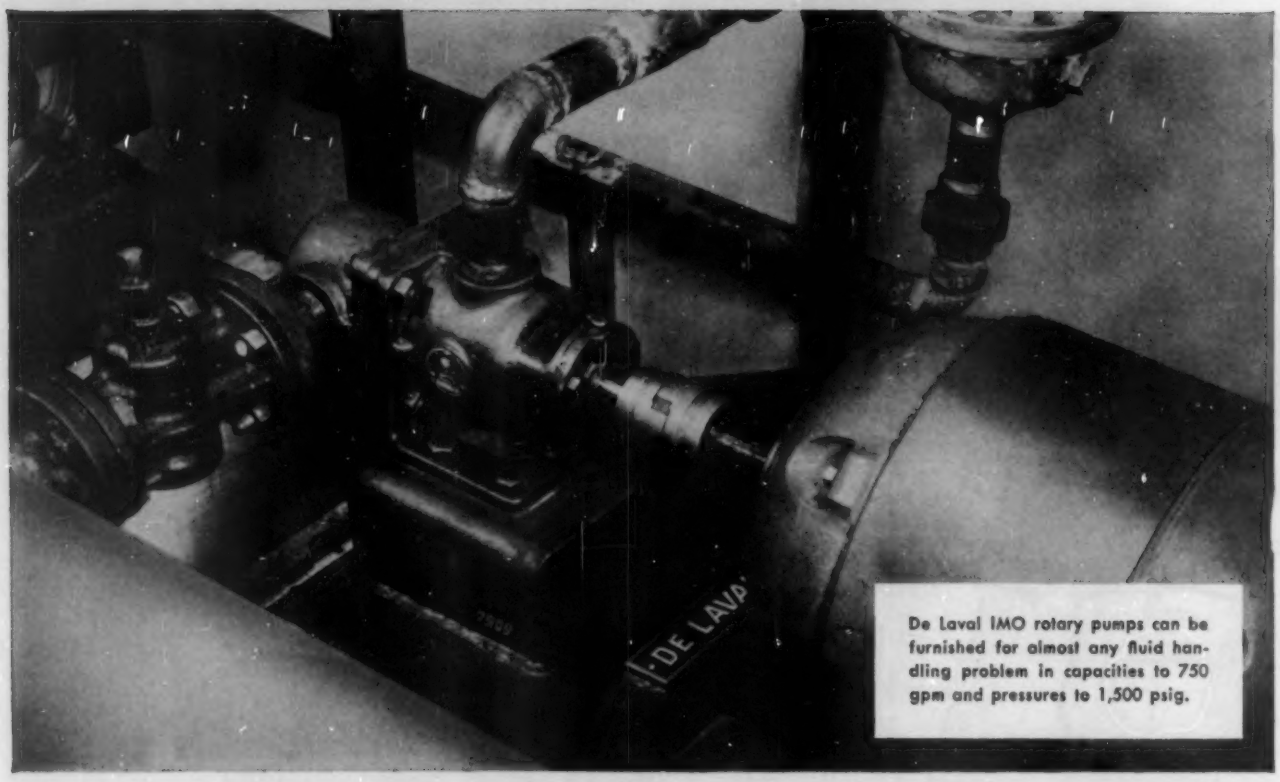


De Laval IMO rotary pumps can be furnished for almost any fluid handling problem in capacities to 750 gpm and pressures to 1,500 psig.

What to Look for in a Rotary Screw Type Pump

By W. J. MONGON, *Assistant Chief Engineer*
De Laval Steam Turbine Company

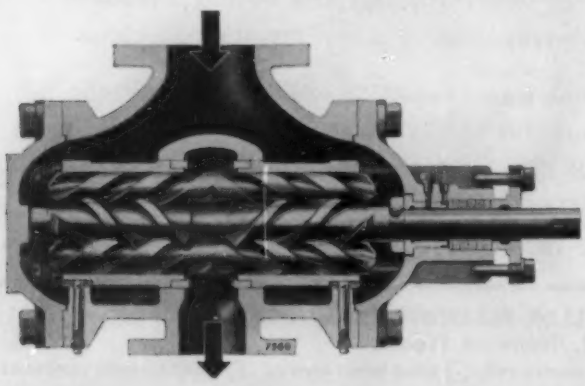
A sound knowledge of design, and how it affects performance, is the best insurance a buyer can have that he will get the pump he needs. This brief analysis of the IMO, a rotary three-screw pump manufactured by the De Laval Steam Turbine Company, will give you some of the necessary facts.

What qualities should you look for in a rotary type pump? It must, of course, meet specified capacities and pressures. But, it must also be efficient, operate quietly, stay on the job.

The axial flow of a screw type pump, and the resulting low inlet losses for any given pump speed, are important benefits that should be considered in making pump selections. The absence of timing gears and other mechanical features of construction also enable the De Laval IMO pump to operate at direct-connected motor and turbine speeds . . . to handle viscous liquids and high suction lifts.

One of the most important features of the IMO pump is the hydraulic turning of the idler or sealing rotors. The central or power rotor is the pumping element; the liquid pumped turns the sealing rotors.

A screw type pump is well suited for applications where pulsation-free flow is desirable. The axial flow of the liquid without trapping and the unique thread form which keeps closures fluid-tight contribute to quiet operation of the IMO pump.



De Laval IMO Series A322A, a positive displacement, rotary screw type pump, can handle capacities to 750 gpm and pressures to 150 psig.

Catalog LS gives useful application and specification data on the IMO pump. An article titled, *Rotary Pumps, Basic Considerations in Their Application*, contains a description of rotary pumps in general. For these publications, write on your company letterhead to De Laval Steam Turbine Company, 801 Nottingham Way, Trenton 2, New Jersey. DL-301

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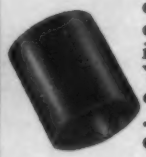

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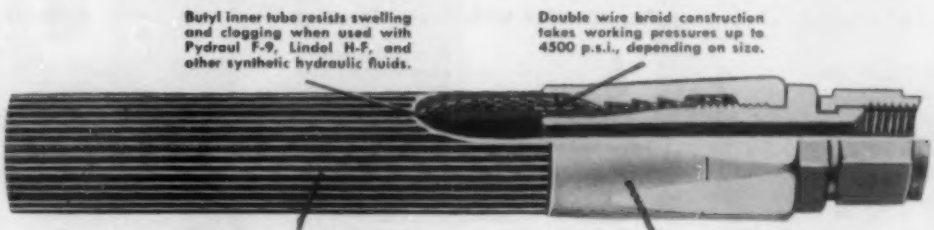
Butyl inner tube resists swelling and clogging when used with Pydraul F-9, Lindol H-F, and other synthetic hydraulic fluids.
Double wire braid construction takes working pressures up to 4500 p.s.i., depending on size.
Tough, green synthetic rubber cover withstands heat, wear, abrasion.
1546 hose mates with standard Aeroquip industrial fittings.

Highly recommended wherever hydraulic lines are used in plant 'hot spots' are the new synthetic, fire-resistant hydraulic fluids. Aeroquip's new 1546 hose has been specially designed to convey these synthetic fluids without swelling or clogging.

Buyers of your equipment can realize immediate money-saving opportunities because increased plant safety means reduced fire insurance premiums in many instances. Other design advantages: Aeroquip flexible hose lines install in a fraction of the time needed to form and fit rigid tubing; Aeroquip 1546 hose and fittings are available in sizes from ¼" to 2" to meet a wide range of product design requirements. Write for complete information.

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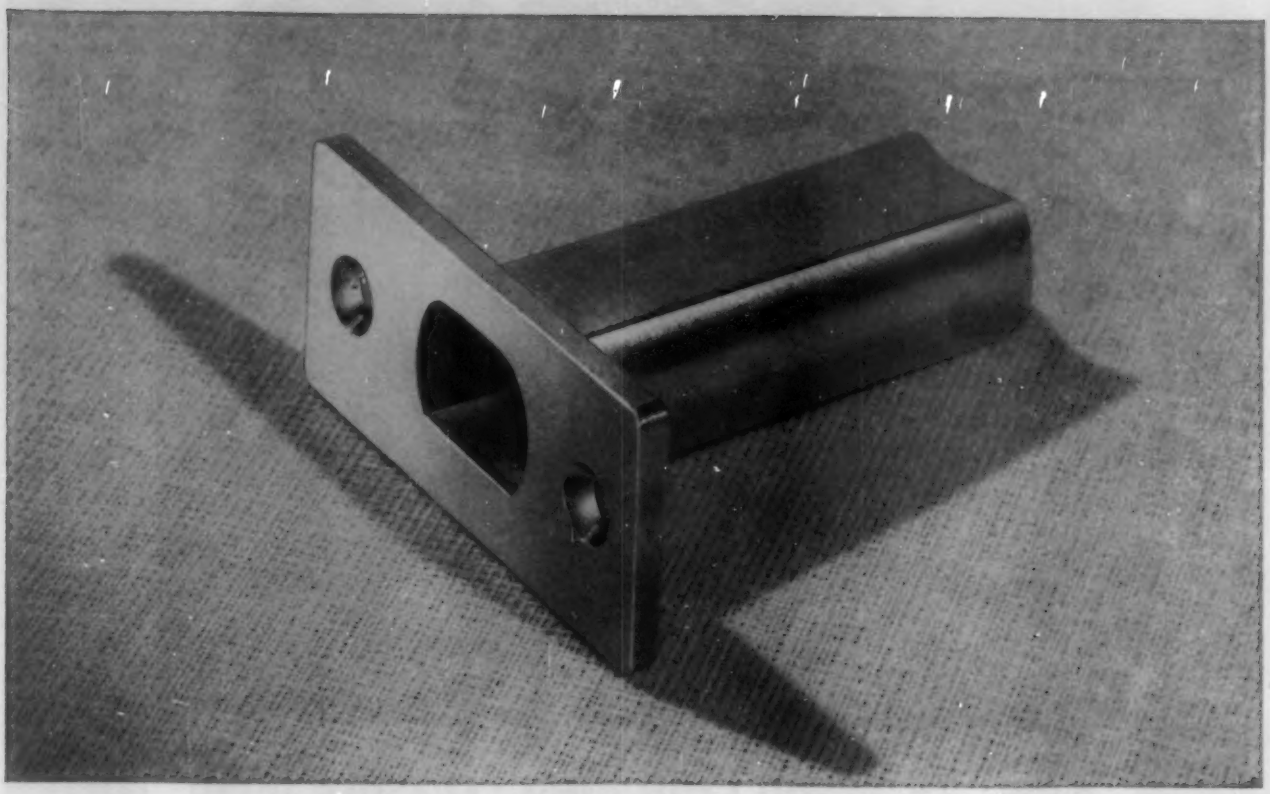
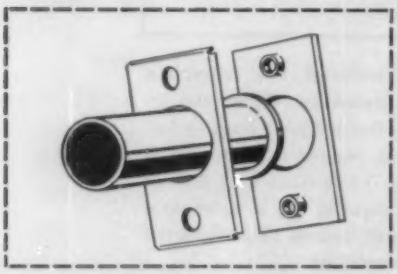


HOW TO MAKE 1 PART DO THE WORK OF 3

A typical example of product simplification with Hunter Douglas Aluminum Impact Extrusions.*

The barrels in most present day door locks are composed of several parts, each of which requires its own tooling, individual press run and a final assembly operation. The part illustrated is typical and construction is fairly standard throughout the hardware industry. It consists of a deep drawn barrel with a flange sandwiched between two mating and piloted plates. Crimping the edges on one of these unitizes the assembly.



Conventional manufacture of this latch bolt includes individual formation of these three pieces plus final assembly and a crimping operation.

Notice the square shoulder formed between barrel and flange. No fillet is required—strength is increased by flow of metal around juncture; fibers remain unbroken.

In an effort to reduce costs and simplify this design, Hunter Douglas recently completed tooling and supplied test parts on an impact extruded component serving the same function.

Even though the part was made from 2S aluminum, the cold working of the metal during the impact extruding process increased strength materially. The resulting part equalled strength requirements of the original design. In addition, the flange was integrally formed with the barrel, without need for joints, seams or fasteners. Impact extruding also insured both zero draft walls of tube and close dimensional tolerances.

The required barrel was unusual—a cylindrical shape with flattened sides. Again, impact extruding proved a most logical means of manufacture...desired part geometry being a direct result of die design and requiring no subsequent forming operations. Actual unit cost of the impact extrusions proved economical—without counting the savings made in tooling.

Typical variations of Hunter Douglas Cold Forgings which serve many industries.

If you are planning design changes or require a hollow component—with or without a closed end—in which zero draft, close tolerances, and high strength factors are desirable, a Hunter Douglas Aluminum Impact Extrusion or Cold Forging might supply the answer. A blueprint, sketch or sample part will bring a quick analysis from our engineering department.

**Hunter Douglas distinguishes parts as Impact Extrusions when formed from soft (2S) aluminum. Parts made from high strength aluminum alloys are designated Cold Forgings.*

DESIGNERS:

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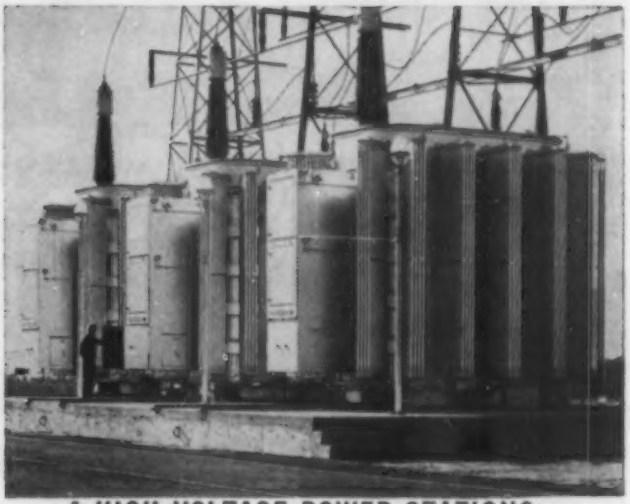

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Enjay Butyl retains flexibility to allow radar screens to operate at sub-zero temperatures. Enjay Butyl's superior resistance to corona and ozone gives better performance with high-voltage cables. Enjay Butyl can withstand high internal heat without becoming brittle, making it ideal for use in underground service cables. And Enjay Butyl's excellent electrical properties and all-weather durability enable it to perform the dual function of insulator and casing for a transformer.

That's why the use of Enjay Butyl in the electrical industry is expanding. To find out how these and other advantages of Enjay Butyl can improve your product, contact the Enjay Company.

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"He loses all...

who loses
the right moment"

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The colorful, spectacular "Ice Follies" is truly a production operation that would be the envy of any industrial executive. The facilities and planning that go into this show are equal to the most advanced industrial manufacturing operations! A 16-car train is needed to carry the personnel, costumes, office, and staging equipment to 23 U.S. and Canadian cities, covering a distance over 20,000 miles each season. It takes 197 specially built castered cases to pack and ship the costumes and staging effects. Years of experience have gone into the design of these cases which are so vital to the needs of this traveling company. All cases have the same basic design for sturdiness and utility. Some filled cases weigh as much as 3280 pounds and others are small enough for one man to lift easily, but all are designed alike. Each case is mounted on Faultless 1121-4 Double Ball Bearing Swivel Plate Casters.

This special case is typical of those used to transport costumes and equipment for the famous ICE FOLLIES. Each case is equipped with Faultless 1121-4 Double Ball Bearing Swivel Plate Casters. Even this trim, young skater can move this large case easily. Model is Miss Beverly Richards, wearing one of the original costume designs made of fur and velvet.

No. 1121-4 TRUCK CASTER WITH DOUBLE BALL BEARING SWIVEL

Note two, large diameter raceways completely filled with hardened and polished balls for easier swiveling. All raceways are full hardened and accurately formed. Choice of wheels to suit load requirements, and floor surface.

The ICE FOLLIES is typical of the efficiently organized companies who rely on Faultless Engineered Casters for materials handling problems. Their choice of the Series 1100 Caster was based on its over-size King Bolt that holds the top plate and ball bearing retainers firmly together for maximum strength and mobility. Your nearby Faultless Distributor has the knowledge and experience to intelligently recommend the right casters for your particular need, delivered right from his stock. Look for him in your phone directory, or write, no obligation.

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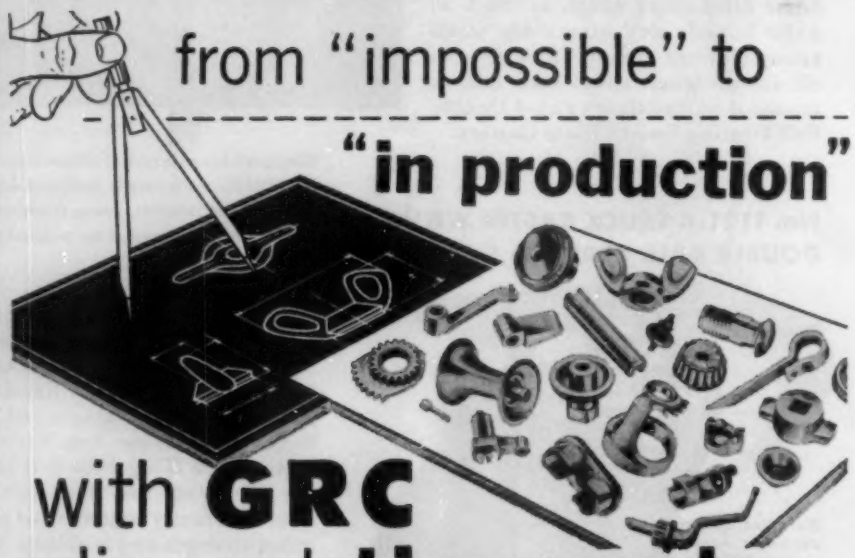

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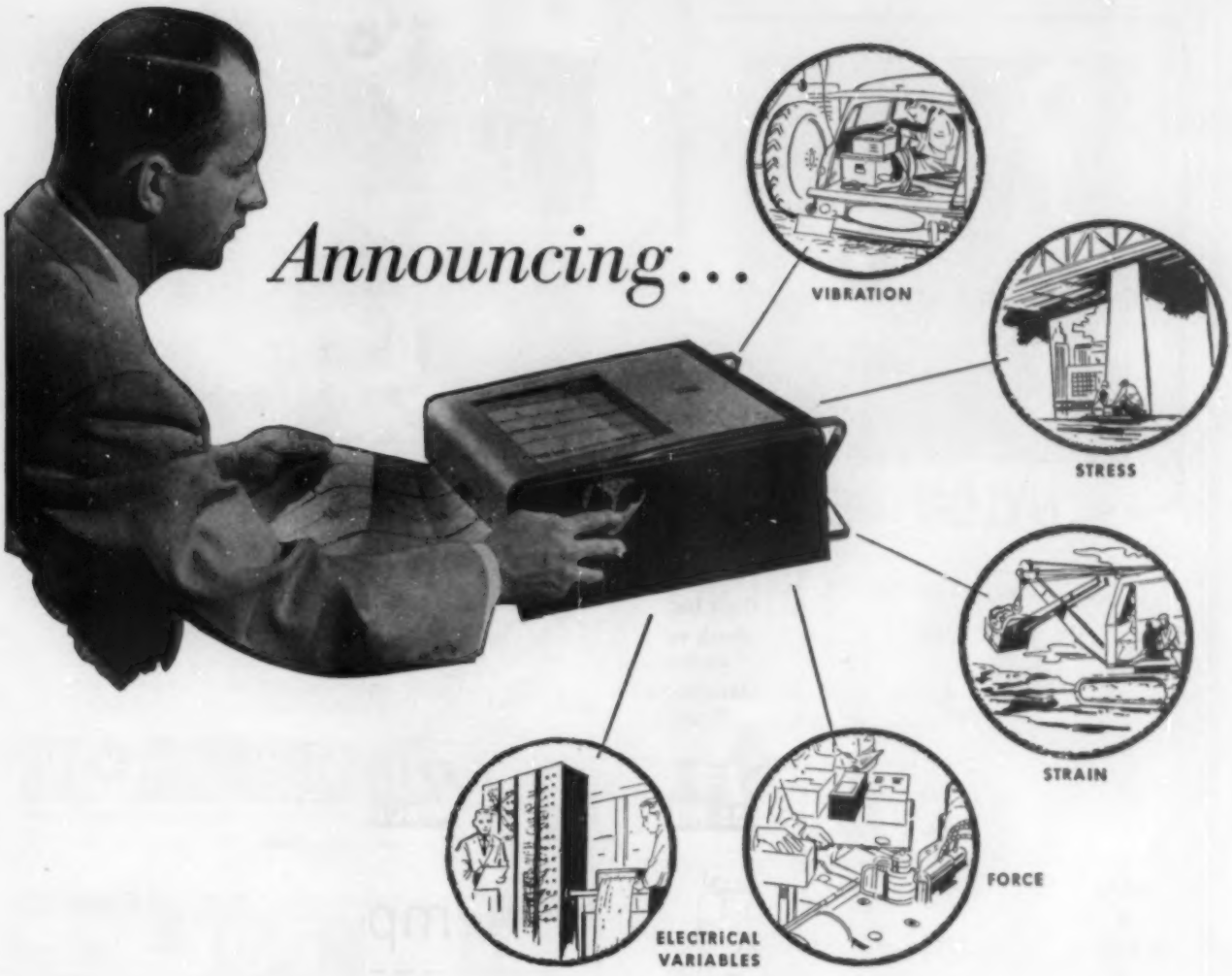

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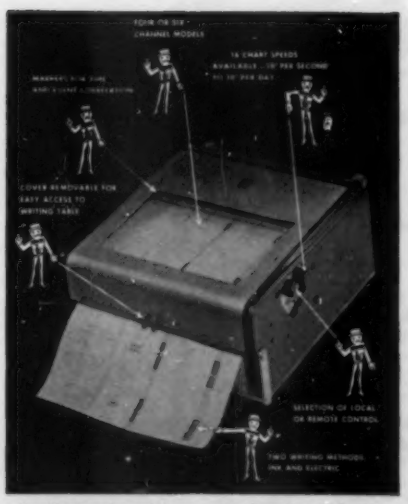
to simplify your data recording



Six-channel oscillograph (above) weighs 48 pounds. Four-channel model weighs only 36 pounds. Both units are equipped with electrically controlled chart drive transmission.

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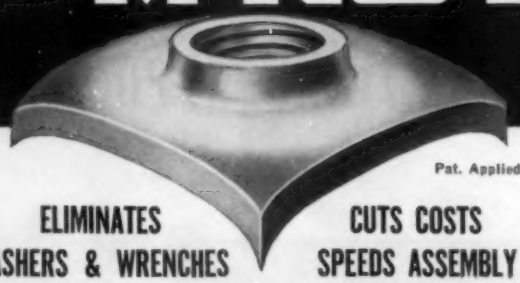

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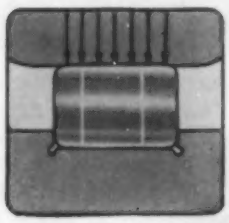

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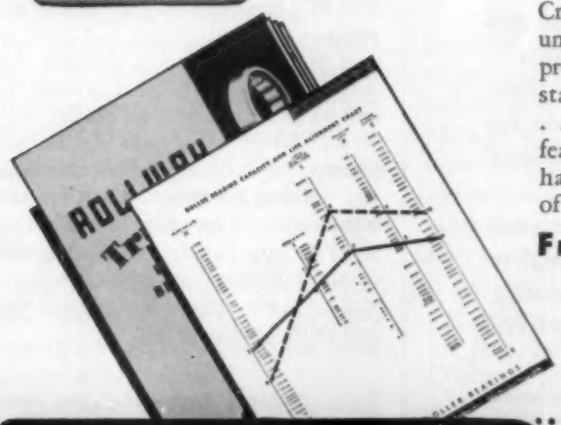
Crowned Roller under full load — stress uniformly distributed.



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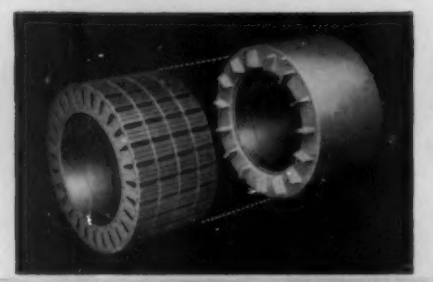
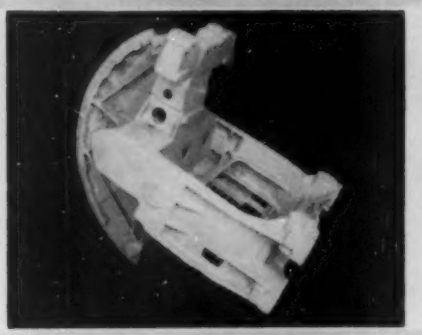


MAGNETIC OUTPUT BOOSTED 10% BY ROLLE MFG. CO.

Rolle advanced casting techniques keep permanent magnet insert temperatures down, yet assure a sound permanent mold aluminum casting. As a result, magnetic output of this alternator rotor is up 10% over best previous attempts.



NIGHTMARE SPECIFICATIONS MET BY ROLLE MFG. CO.

Complicated internal structure, unequal wall sections, complex wall joinings, intricate internal webbing, make feeding and chilling stressed areas a nightmare in this sand casting. But Rolle Manufacturing is turning out castings able to pass 100% X-ray examination to highest aircraft standards in production quantities.

CASTING COSTS CUT 44.5% BY ROLLE MFG. CO.

Rolle recommended change from sand casting to permanent mold casting of this part, with guaranteed surface in required areas, between fins, of from 100 to 125 microinches. Change resulted in casting costs down 44.5%, and machining time cut in half.

ROLLE CAN SOLVE YOUR CASTING PROBLEMS

Your casting problems—sand or permanent mold, aluminum or magnesium alloys—can always be solved quickly and economically if you bring them to Rolle. But the advantages of fighting weight with strength with Rolle don't stop there. Some of the most impressive savings Rolle has made for customers involved castings that were never considered "problems."

You can get some idea, just from the few cases illustrated here, of how the use of advanced techniques . . . a change in casting method . . . variation in any of a hundred casting considerations, can bring immediate returns in either reduced costs or improved performance, or both.

Write now for a free booklet that tells how you can solve casting problems with Rolle.

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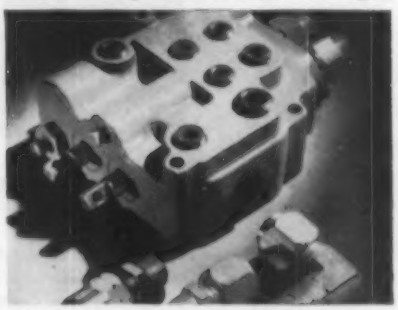
Compare actual samples. Ask your Parker representative to check your specifications and design. Let him prove how Parker O-rings seal better, last longer.



What other Parker products interest you? *Triple-lok* flare tube fittings? Ferulok flareless fittings? *Hoze-lok* fittings? Hydraulic directional control valves?

. . . then call in your Parker field engineer for help

Having trouble with O-ring failures? Nibbled, worn, battered, leaking like a sieve? Whether your problem is in the basic design or compound, it's time to call a Parker representative.

Parker field engineers are trained trouble shooters. There is one in your area. From Parker you can get exactly the *right* O-ring and gland design for your *specific* application.

Compare Parker O-rings with any other make. You'll find that Parker O-rings are precision-molded of superior compounds. They have been developed as the result of years of experimentation to provide the proper elongation, tensile strength, compression set ratings, resistance to oils, fuels, chemicals, and high and low temperatures. Laboratory and service tests make sure that all rated characteristics are held.

Call your Parker representative for assistance. Mail the coupon for *free* technical bulletins about O-rings.

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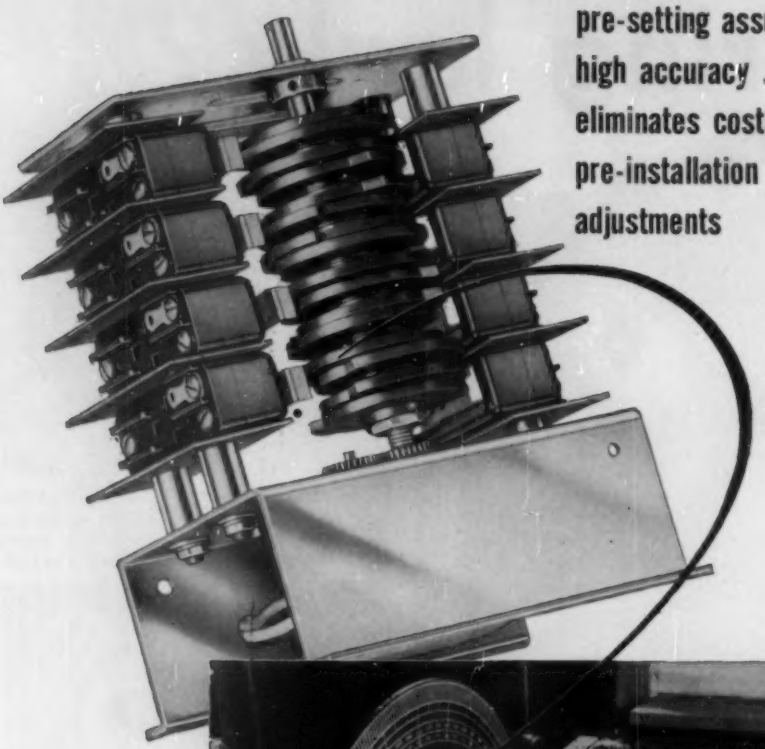

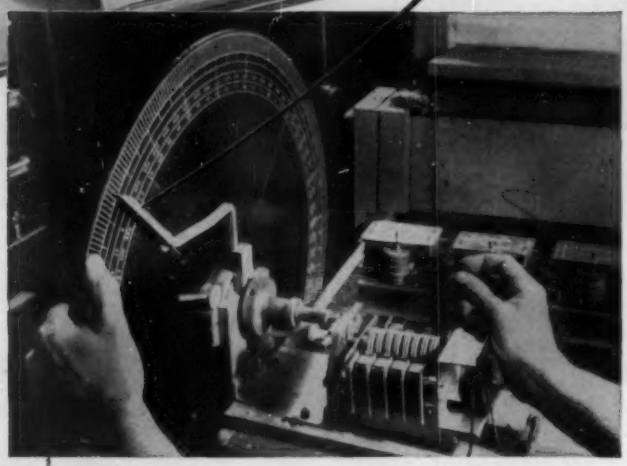

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The accuracy of a cycling timer depends on the exactness of the cam settings. If any one of the driving cams is incorrectly set, even to the minutest degree, the over-all program pattern or sequence of operations is changed.

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For full information about Cramer Cycling Timers, write for new Bulletin PB-510.

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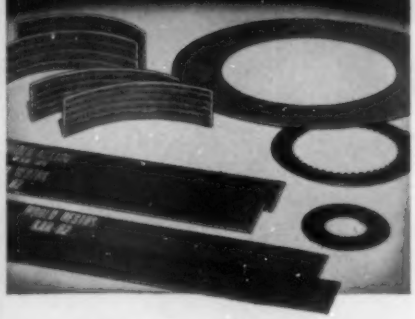

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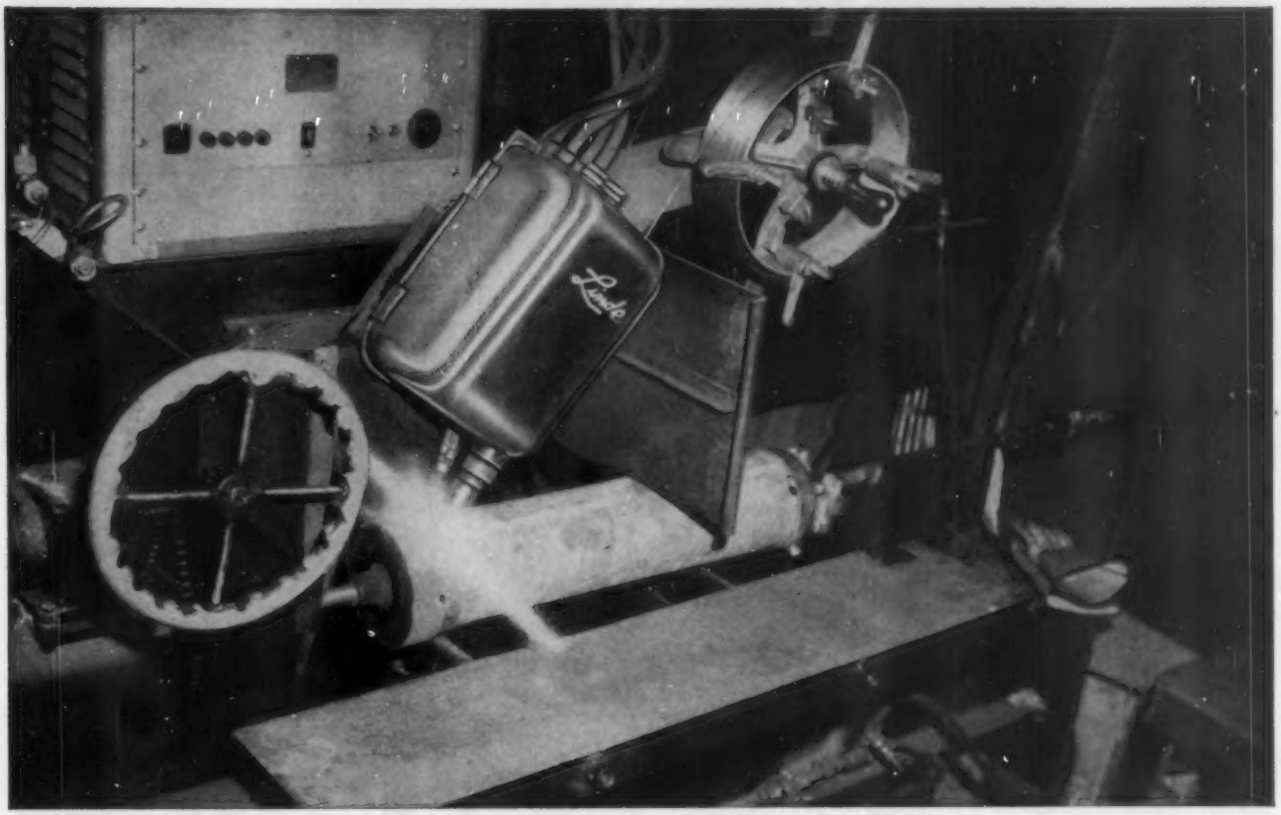
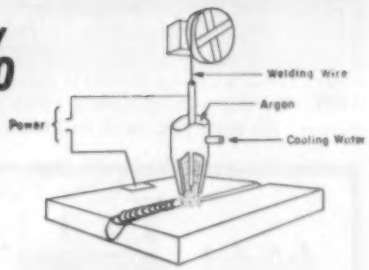


Sigma Welding...Cuts Costs 36% Ups Steel Fabrication 93%



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All completed condensers are subject to an air pressure test under water, and a supersensitive electronic leak detector . . . Rejects have been practically eliminated by sigma welding. Like many other products throughout industry, these condensers are being fabricated faster and more economically than ever before. Here are some sigma welding features—

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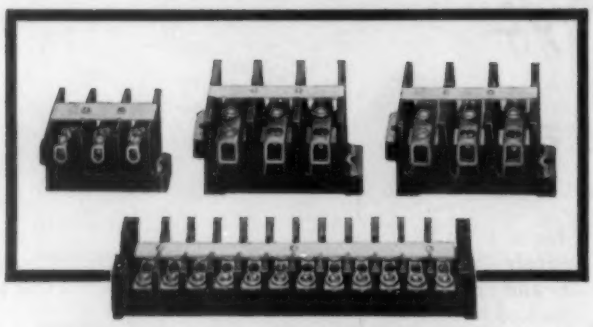

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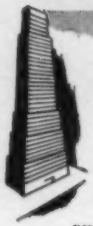

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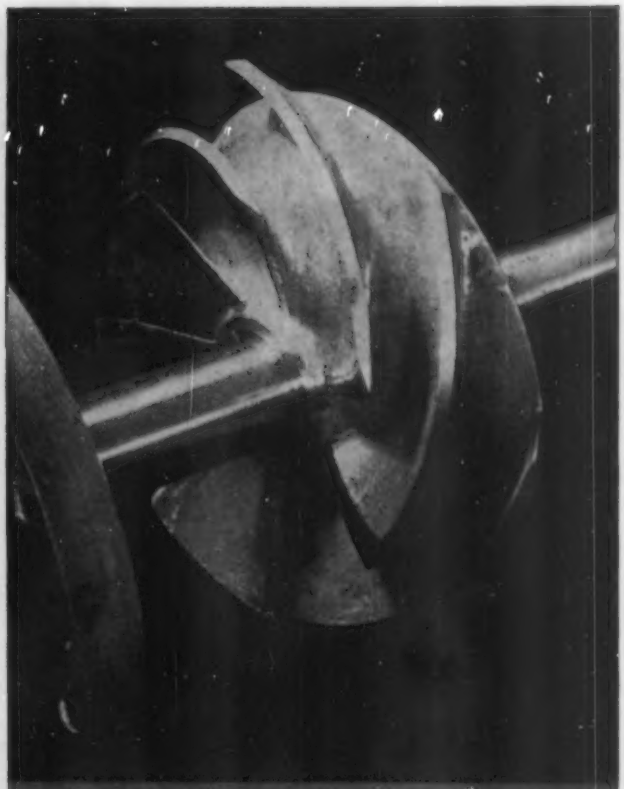

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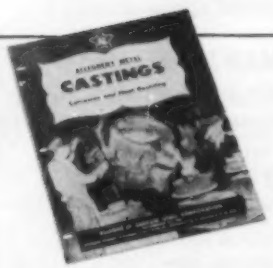

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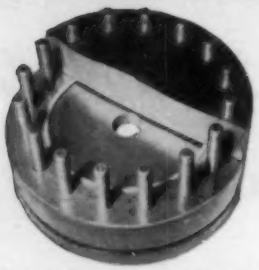

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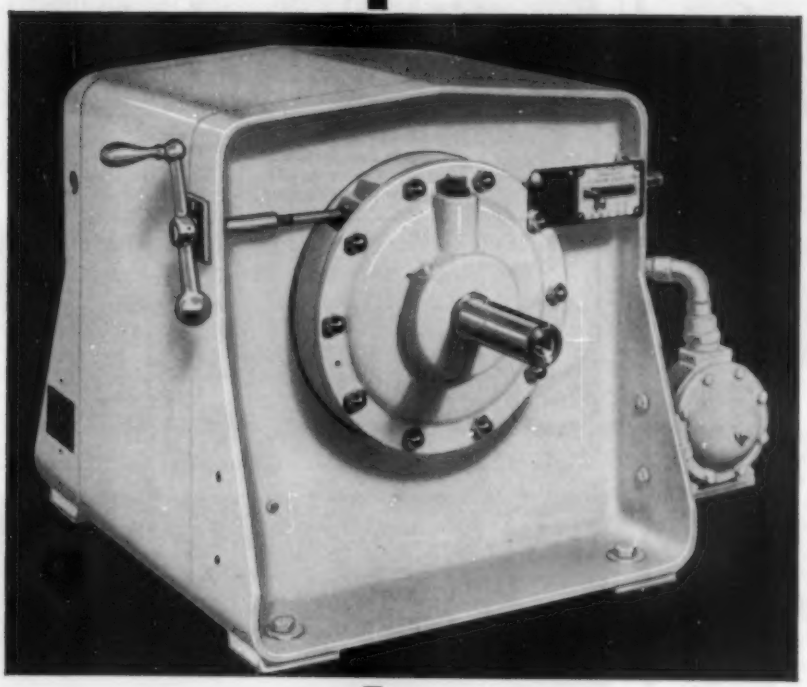

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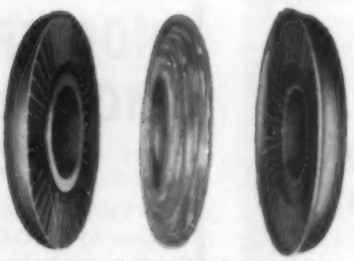
Principle of operation of Gýrol Fluid Drives



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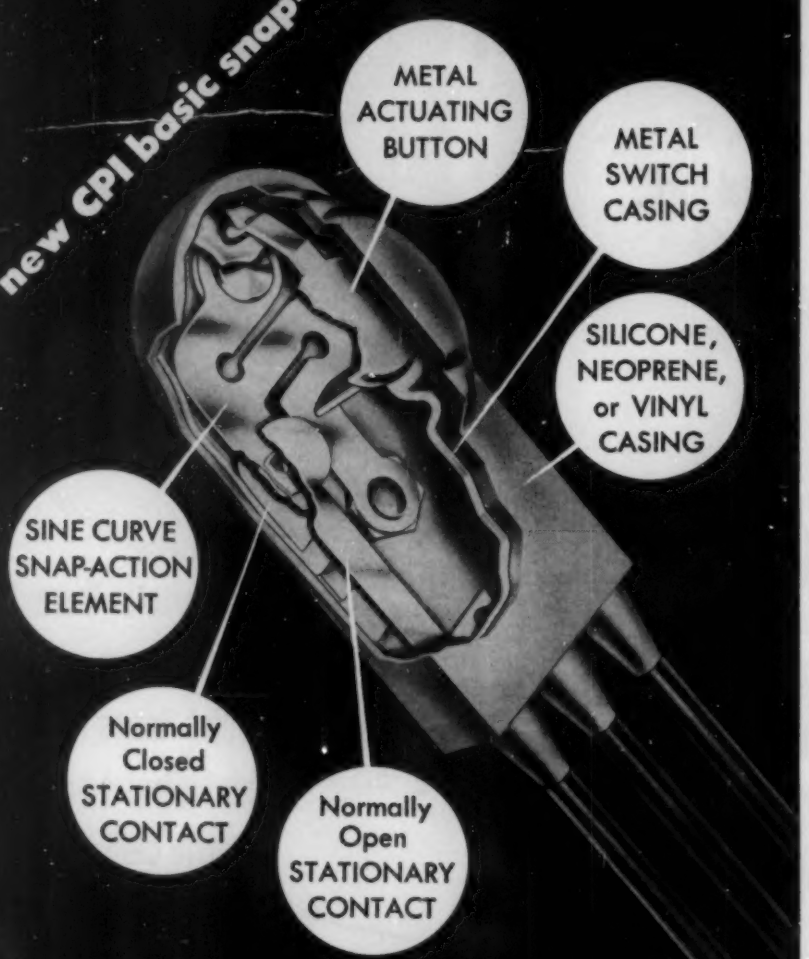

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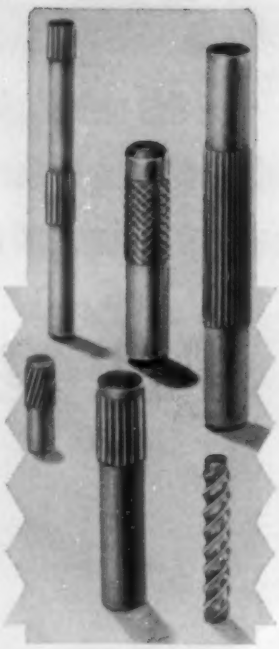

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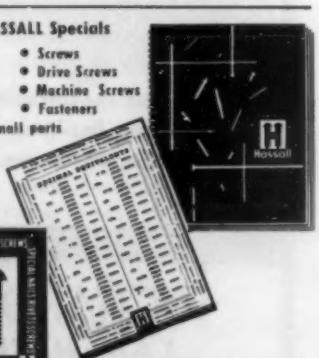

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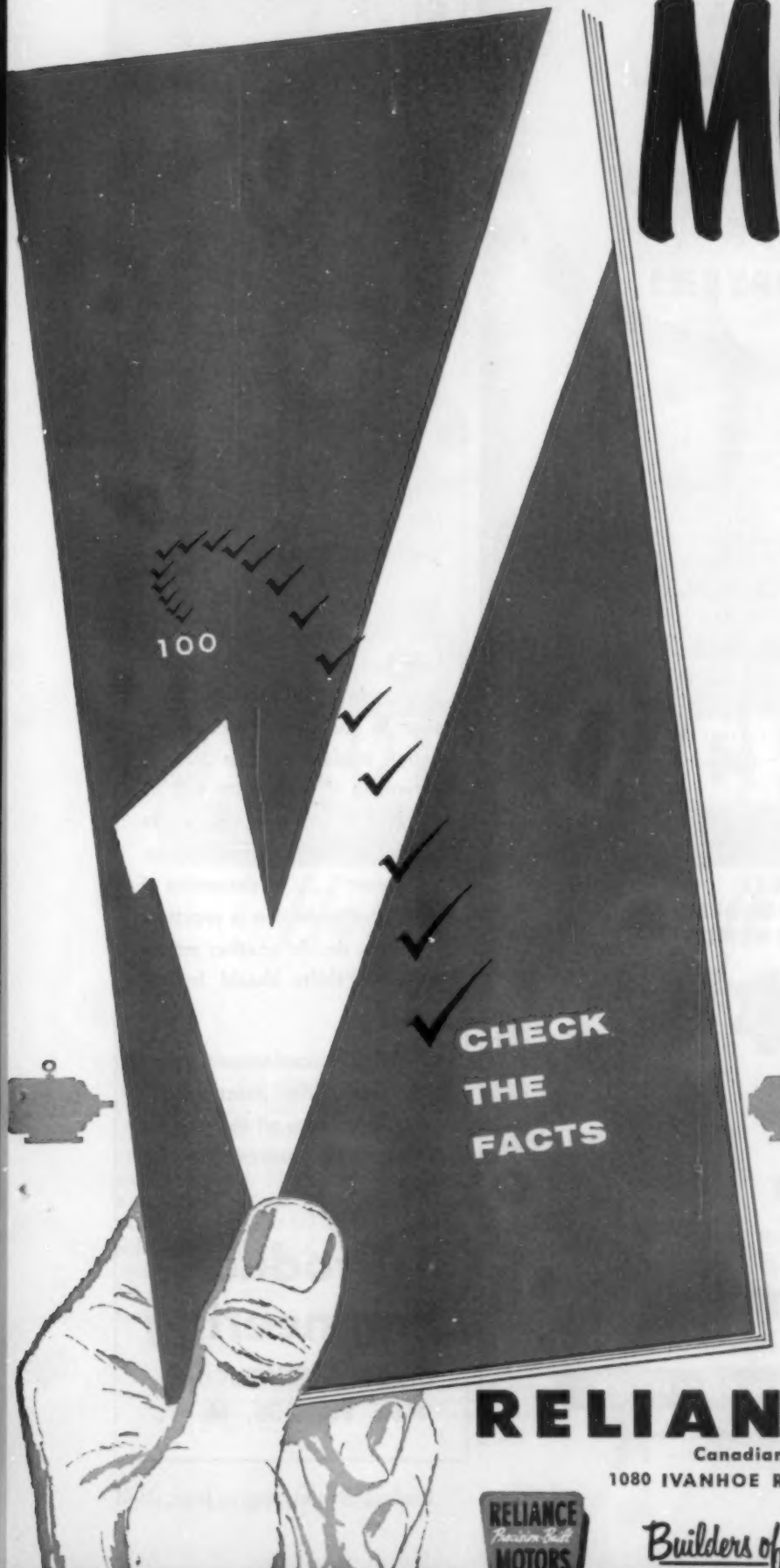

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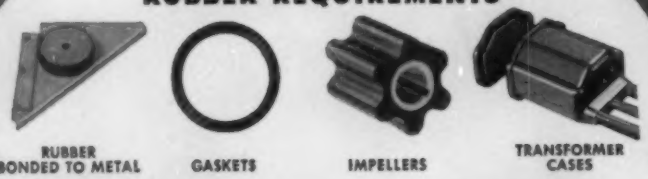

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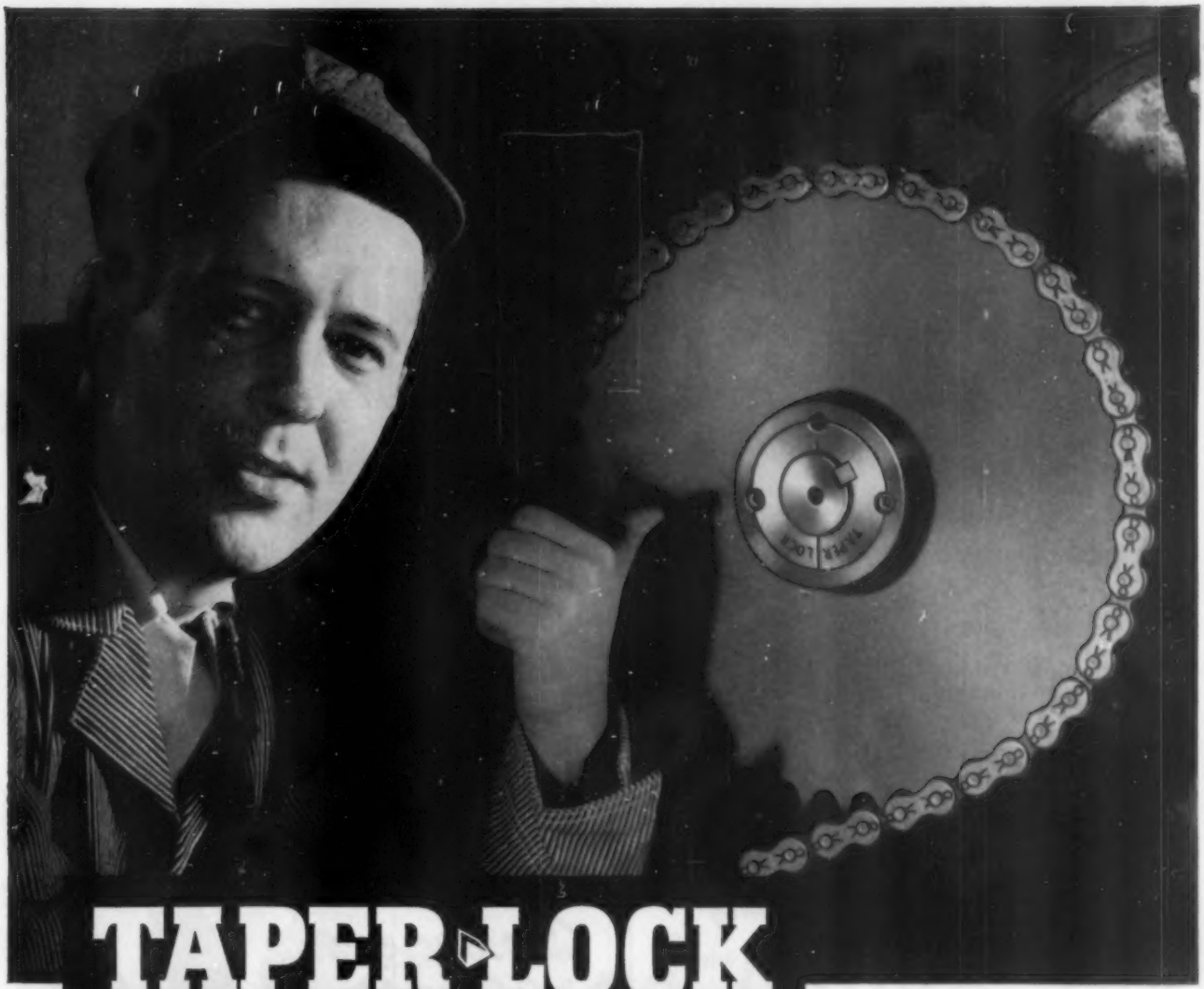

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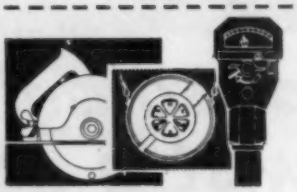

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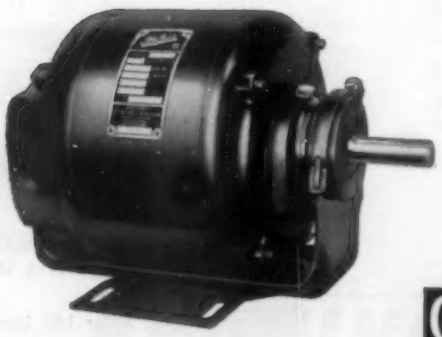

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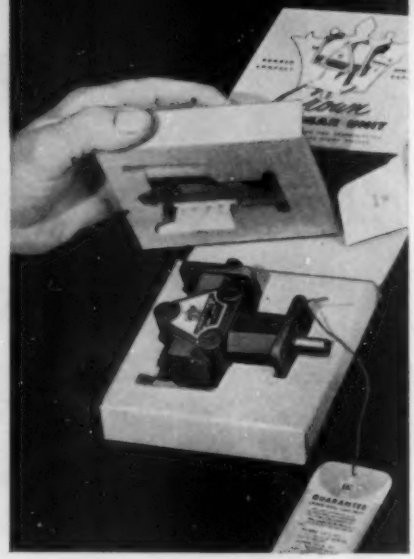

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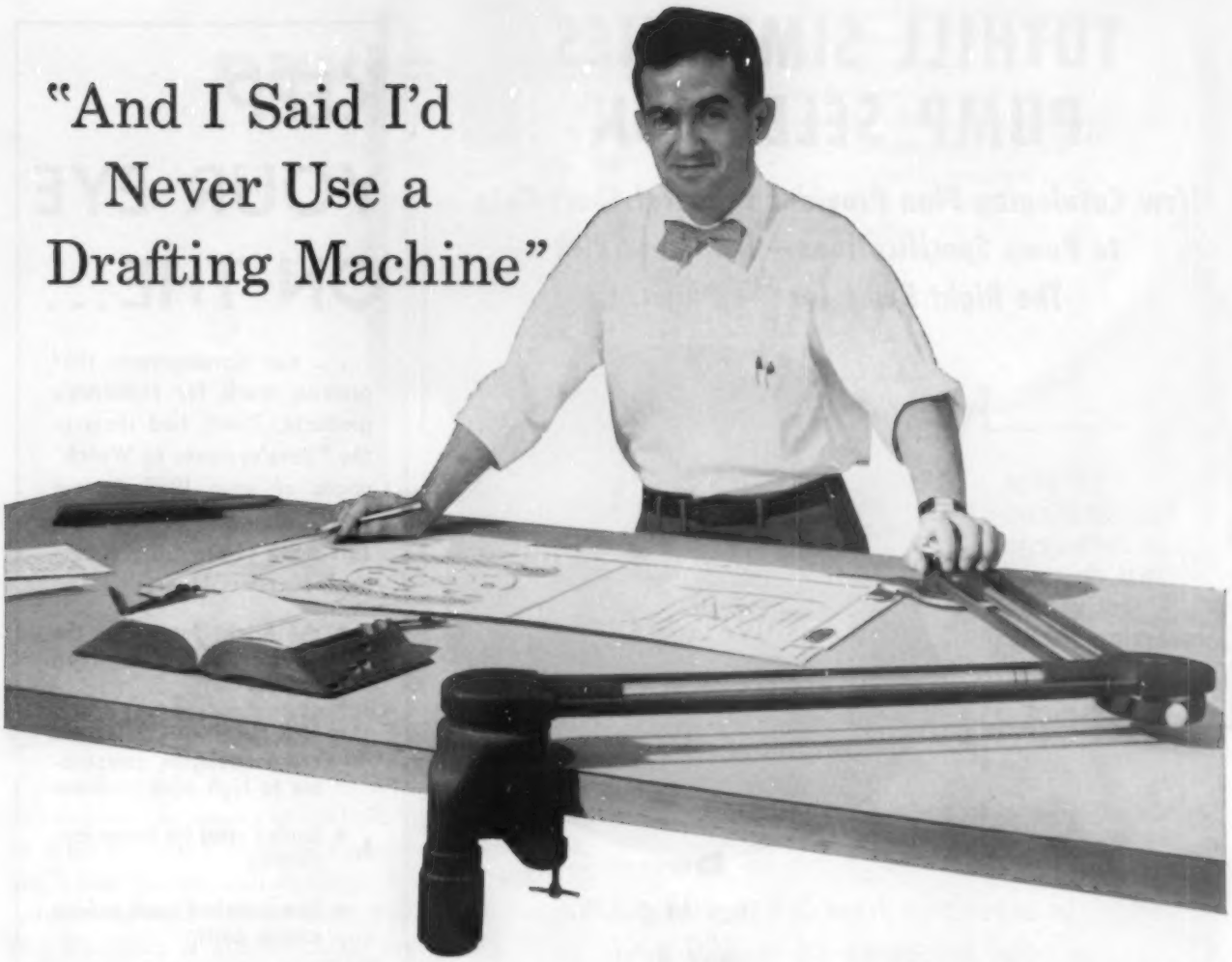
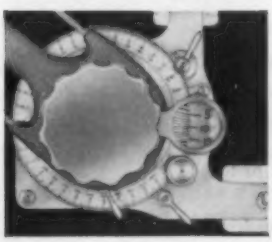


"That Was Before I Tried a Bruning Equipoise Drafter!"

Bruning Counterbalanced Drafters and Bruning Track Drafters provide fast, easy, accurate drafting on vertical boards and on extra-large drawings.



Bruning Equipoise Drafters are available with either the Civil Engineer protractor head, shown here, with its special azimuth scale, or the Standard protractor head.

Take a tip from an increasing number of draftsmen who, perhaps like yourself, were reluctant to try any drafting machine or had been disappointed in a conventional type drafter. These men now report: Bruning Equipoise Drafters cut drafting time over conventional equipment up to 40% on most jobs, up to 50% on some structural drawings — beat any other drafting machine they ever tried.

But prove it to yourself! See how fast you'll work with one precision instrument combining T-square, straightedge, triangle, protractor, and scales. Feel how the patented Equipoise mechanism eliminates any drift from gravity, literally makes the drafter "float" into place. Find how easy it is to rotate, turn, and lift this drafter — all with the left hand. At the same time, operate the Touch Control button with your left thumb to set the drafter automatically at any of 24 commonly used 15-degree increment angles. Don't overlook the special scale lock that makes it easy to change the scales, holds the scales rigid.

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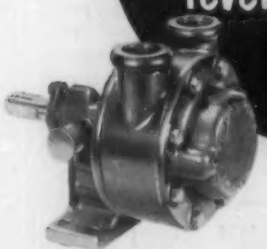

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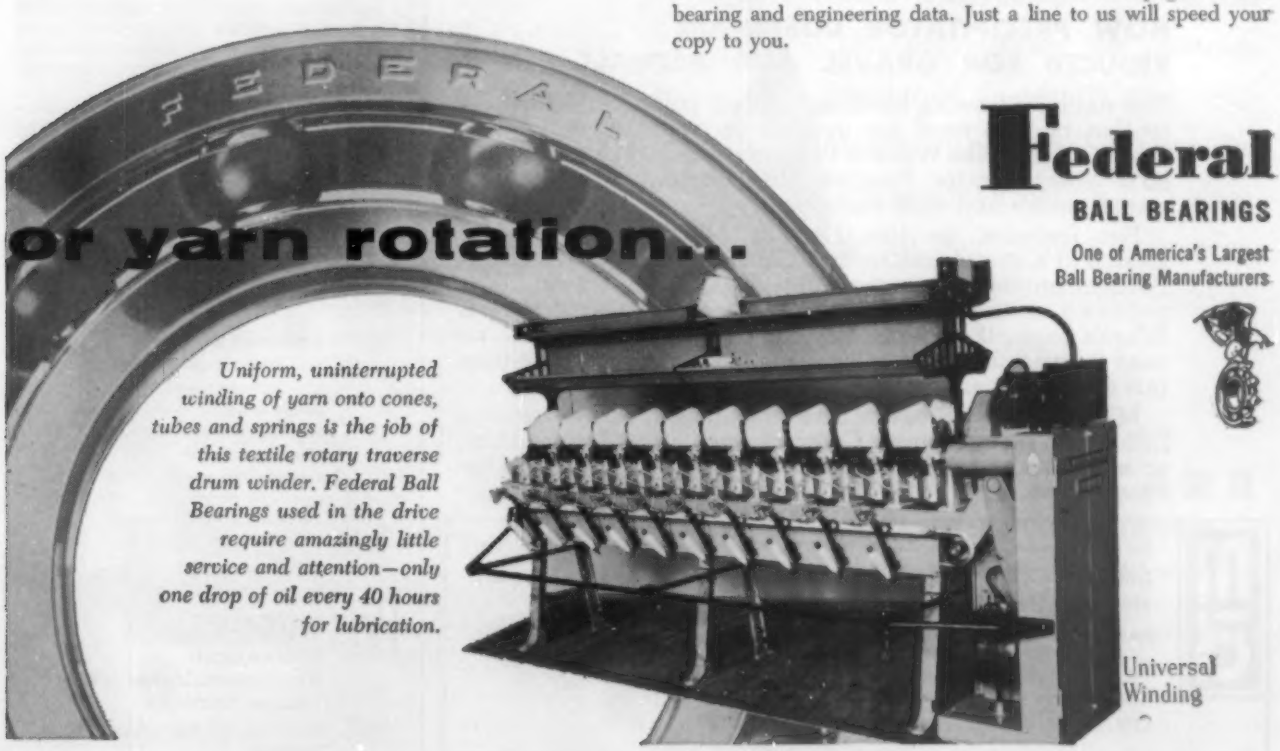

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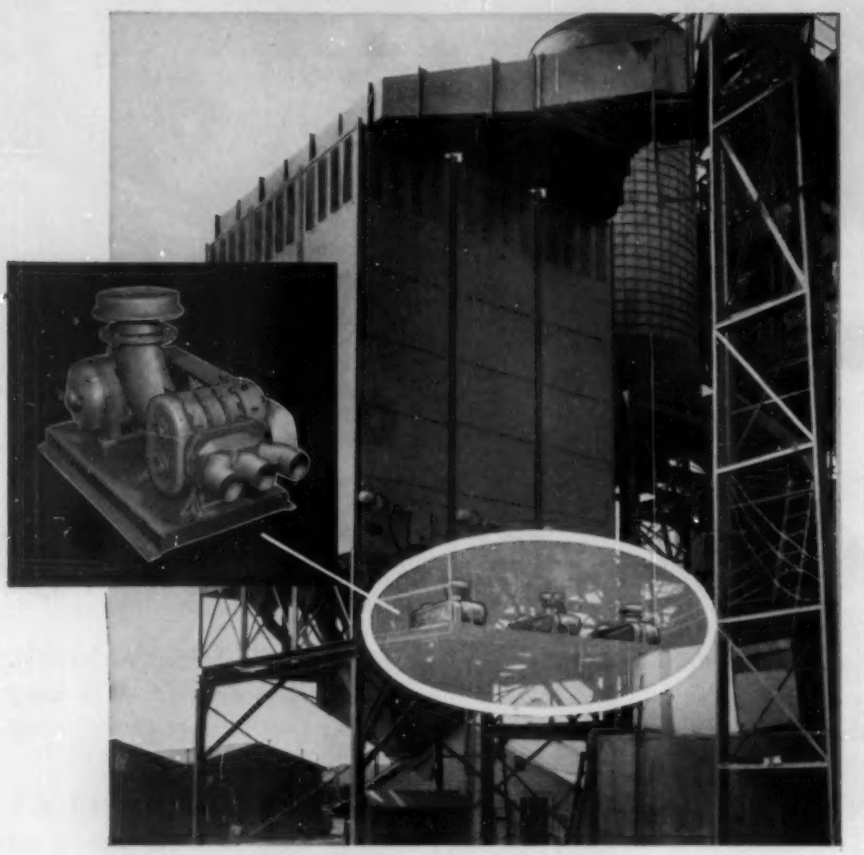

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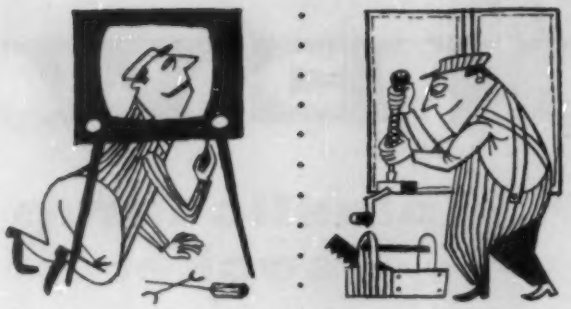

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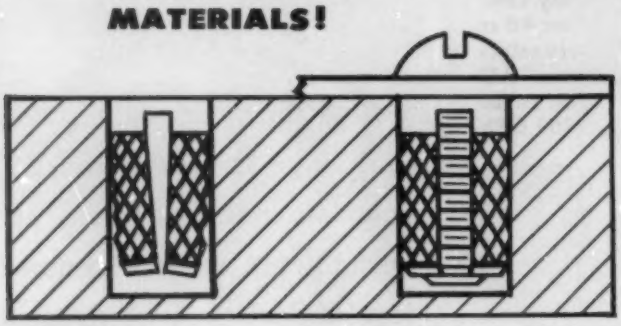

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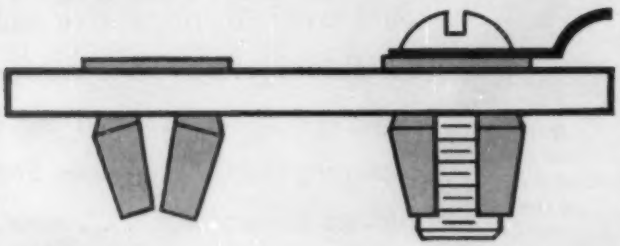

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Light metals design tips

FS-ALLOY					M-ALLOY				
Thickness Each Sheet in.	Average Spot Diam. in.	Typical Single Shear Strength pounds	Minimum Shear Strength pounds	Lowest Average (Lot of 20) pounds	Thickness Each Sheet in.	Average Spot Diam. in.	Typical Single Shear Strength pounds	Minimum Shear Strength pounds	Lowest Average (Lot of 20) pounds
.020	.14	220	86	115	.020	.12	120	64	85
.025	.16	270	121	161	.025	.14	160	89	120
.032	.18	340	174	232	.032	.16	220	128	172
.040	.20	430	232	311	.040	.18	280	172	229
.051	.23	540	314	419	.051	.21	370	232	309
.064	.27	680	410	547	.064	.24	480	303	405
.081	.31	860	543	725	.081	.28	620	349	465
.091	.33	950	623	830	.091	.30	700	460	615
.102	.34	1080	734	977	.102	.31	790	542	723
.125	.38	1320	920	1227	.125	.35	990	680	907

This table shows advantageous spotweld properties of magnesium

As shown above, the spotweld properties of magnesium sheet make it practical for a wide range of product applications. In fact, within the limits suggested by this table, it is often the quickest, most economical process for joining magnesium parts.

Experience shows that either electronic-timed A.C. welders or stored-energy-type D.C. welders can be used. Manual control of either pressure or weld time is not satisfactory. Higher currents are required for spotwelding M alloys than for corresponding thicknesses of FS alloys. More frequent tip cleaning is required with M alloys than with FS alloys (approximately every 25 spots for M vs. every 100 to 200 spots for FS).

Material is cleaned prior to spotwelding to insure uniform surface resistance of not more than 50 microhms. Parts are cleaned either chemically or mechanically, depending on their size and shape.

Write for our handy table, "Recommended Spotweld Edge Distances and Spot Spacings." And, whatever your light metals problems . . . count on Magcoa engineering counsel and fabrication facilities.

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LIGHT METALS FABRICATION DIVISION • EAST CHICAGO 27, IND.

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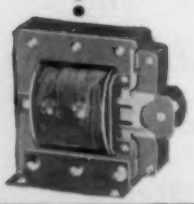

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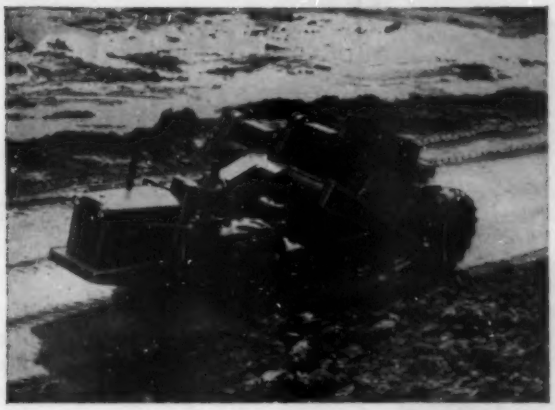
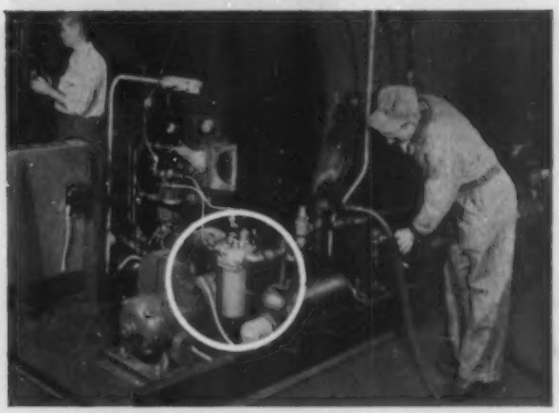
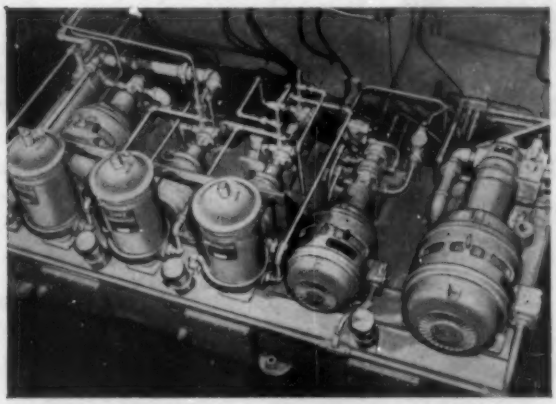


POWERFUL LeTOURNEAU-WESTINGHOUSE Tournapulls, equipped with Cuno MICRO-KLEAN 2-element lube oil filters, work efficiently in areas inaccessible to other earthmovers. When they've got a tough filtration problem, leading manufacturers like LeTourneau-Westinghouse know they can depend on Cuno for the right answer.



FUEL OIL. Leading boiler manufacturer uses continuously cleanable, all-metal Cuno AUTO-KLEANS to filter #6 and #7 fuel oil. He says, "... filter results are very satisfactory. Maintenance of filter is at the minimum." AUTO-KLEANS come in steel, brass or stainless; capacities range all the way from 1 GPM to 3,760 GPM.



HYDRAULIC FLUID. 50-micron Cuno MICRO-KLEAN filters protect precision parts in hydraulic and lube systems of way bed and worm drive box on this horizontal broach. MICRO-KLEAN provides full-flow filtration and protects cylinder rams, liners, valves and other parts.

LUBE OIL. Specially designed AUTO-KLEAN filter after green run in the lubrication system of automotive-type gasoline engine in military service. Note the core sand, sealing paint, lint and metal chips accumulated after only a few hours' operation — graphic proof of the need for full-flow filtration here.

10.4.16

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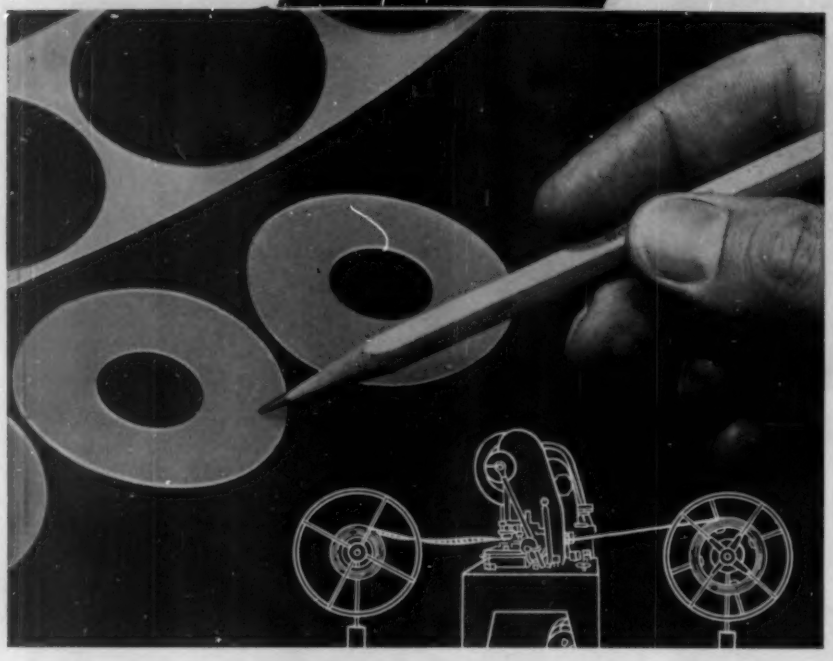

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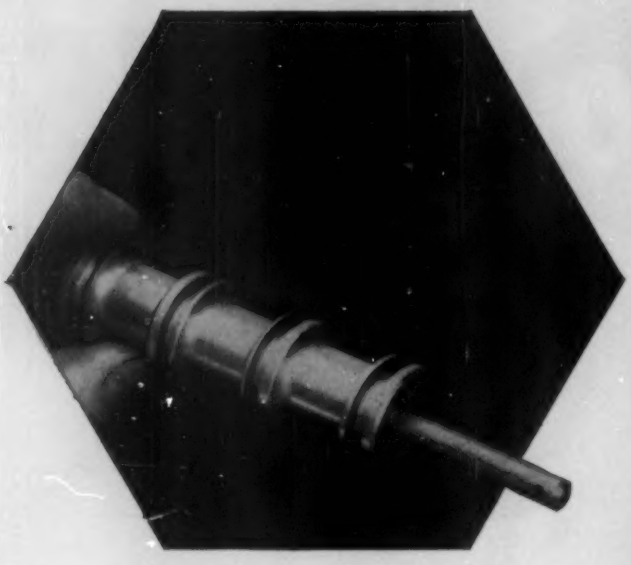

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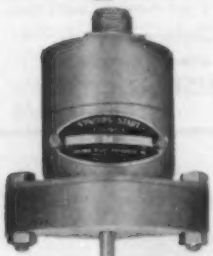
with A N CONNECTOR



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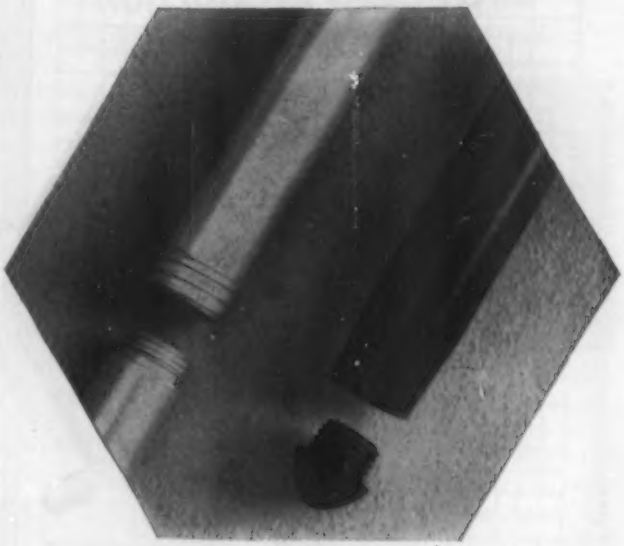
this aluminum part



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Write for free literature describing the investment casting process.

CASE STUDY

DESIGNATION: Impeller for flowmeter.
METAL: Magnesium, Dowmetal C.
QUALITY CONTROL: Produced under radiographic control.
PARTS: Designed and cast as single unit.
ADVANTAGES: Fine grain and smooth surfaces. Annular passages without draft. Now standardized because of top quality at bottom cost.

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Available in a full range of densities, sizes, and thicknesses and soft, medium, and firm grades *ARco-CEL is made up of individually sealed cells of inert nitrogen.*

Light, moisture-proof, soft, ARco-CEL is an *insulating and shock-absorbing material*, broad in manufacturing applications, and ideal for many industrial and scientific purposes. It can be die-cut, split, laminated, and bonded to other materials. Some forms of ARco-CEL can be molded into special shapes.

Descriptive folder available on request.

Anything can be covered with rubber . . . by ARco!
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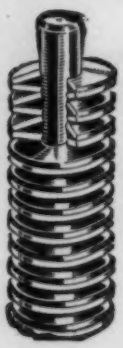
Why SCHNORR Disc Springs?



BECAUSE

1. Unlimited life within borders of permissible loads.
2. No creeping, initial settling or gradual fatigue.
3. Axial center pressure.
4. Exact adjustment to the desired pressure.
5. Small constructional height, large deflection.
6. Large inherent damping.
7. Large impact damping especially with multiple stacking.
8. Excellent space disposition.
9. Spring pressure, Spring length and Spring deflection can be easily determined for the same Spring size or can be changed by lengthening or shortening of the Spring columns or by multiple stacking. In special cases the character line can be made to divert from its usual form by diversified stacking.
10. Most Spring sizes available from stock.

For Descriptive Literature Write

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CORNING GLASS BULLETIN

FOR PRODUCT DESIGNERS

Ingredients for light that's absolutely right . . .

Light that really meets the needs of surgeons must be glareless, shadowless, cool and color balanced.

That's the kind they get from the Wilmot Castle Company's surgical lights. Glare and shadows are disposed of by an ingenious metal reflector of Castle design.

Cooling and color balance are handled by a *special* glass we make—for use in Castle lights. Called AKLO, it blocks infrared waves emanating from an artificial light source by converting the infrared into molecular heat.

A piece of AKLO 4 mm. thick absorbs some 87% of the infrared waves. Result—after an hour of continuous exposure, for every 1,000 foot-candles of illumination, a thermometer 20 inches from the light source shows a rise of less than 3° F.

Light from AKLO is the right *hue*, too, since it eliminates the greenish cast normally associated with heat-filtering glasses. And, this light is as close to natural as it's possible to obtain from artificial sources. That's a vital point in proper diagnosing of pathology, and in observing a patient's coloring.

AKLO's light is also balanced in terms of temperature. It runs to about 4,000° K., just right for shooting accurately rendered color movies and telecasting operations in color.

AKLO is one example of Corning's several successful conquests of problems involving energy control.

Experience suggests that there's more than just an outside chance that any pressing energy control problem you may have can be effectively (and economically) coped with by a glass we already make.

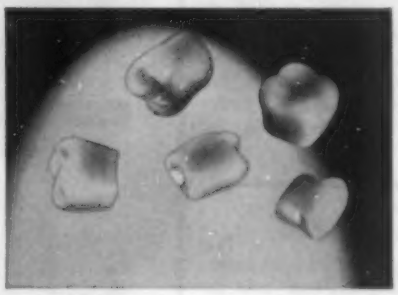
If you want to find out, drop us a note about your problem wave. We'll peer into our files and let you know *which* glass, if any, can do the job.

Denture adventure

A dental chap, we learn, is experimenting with glass for artificial teeth.

He's molding them from a mixture that's mainly ground-up VYCOR brand glass. Reason? Ordinary enamels don't stand up very well under the high heat needed to set the teeth in rubber. VYCOR brand glasses do. Result? Savings in breakage, annoyance, and time.

VYCOR brand glasses come in seven different forms. Basic characteristic of all is a very high percentage of silica—96%. It's the silica which makes the VYCOR brand glasses almost immune to temperatures up to 900° C. (higher under certain operating conditions) and endows them with unusual resistance to thermal shock.



The thermal properties of the VYCOR brand glasses make them useful in such products as calcining jars, thermocouple protector tubes, sight glasses for high heat furnaces. And ability to handle ultraviolet and infrared rays make them favored contenders for use in germicidal lamps, sun lamps, photochemical lamps and the like.

This is a far cry from our starting point on dentures, but, it may help you to see that the VYCOR brand glasses are both versatile and quite remarkable.

Bulletin B-91 details types, physical characteristics, and present uses of these glasses. Your name in the coupon will bring the literature to your desk.

Print it in glass!

These pictures tell the story much better than words.

Designs, name plate, dial face—they're all printed in glass. Not *on* glass, but *in* it!

The glass is called *Photolay*. One of the things that intrigues most people who see a picture printed *in* Photolay is its three-dimensional effect. It has depth. The image seems to float in the glass with all the attributes of reality. Even lettering, or a line drawing, acquires a special sort of difference.

Besides, an image in Photolay is permanent. It won't ever fade, get scratched off, or tarnish.

Photolay is one of several photosensitive glasses developed by Corning. They all have this in common: When exposed to ultraviolet light through a negative, a latent image forms right in the glass. Heat treatment develops this image.

What's it good for? Maybe *you* have some ideas a photosensitive glass might give a special twist to. So far, stove and appliance manufacturers have put it to use in name plates, escutcheons, dials and such. If your problems are similar, let us know.

If the items discussed here seem unrelated to your immediate interests, we still may have what you need at our fingertips. We'd count it a pleasure to hear from you.

Corning means research in Glass

CORNING GLASS WORKS

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Please send me Bulletin B-91 on the VYCOR brand glasses.

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The experience gained from the manufacture of over 3½ million magnetos is embodied in the Fairbanks-Morse flywheel magneto. Sturdy and simple it has a molded heavy-duty high tension coil, large long-lasting breaker points and Alnico permanent magnets. It has a proven record for top performance and easy starting.

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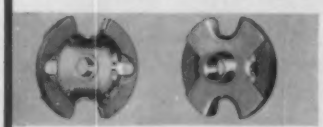
Instead of meshing gears and pawls, this starter is mounted over and engages on a regular rope starter pulley. Just grasp the handle and pull—it engages instantly and automatically. When you release the rope, it rewinds inside the starter automatically. Made principally of aluminum alloy it is 50% lighter than other type starters. The fray-proof nylon pull cord will last the lifetime of the equipment.

CENTRIFUGAL CLUTCH



These clutches are highly resistant to heat and shock and are being used on some of the most rugged applications possible. Approximately 80% of all chain saws are equipped with this clutch—a really tough operation. It is very simple with few working parts. A wide range of engaging speeds are possible because the springs can be adjusted to fit the specific application.

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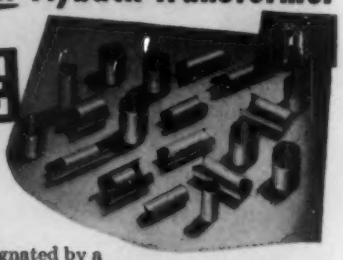

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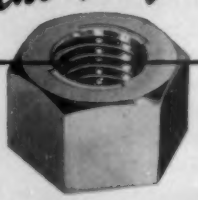

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We may want to call you by telephone. So please include your phone number and the best hours for receiving calls.

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An authoritative article discussing in detail this very important phase of product engineering is as close as your 1955 Annual HANDBOOK of *Product Design*.

In an outline of the factors to consider when analyzing the functional approach, this one of many HANDBOOK articles covers a wide range of operating and environmental conditions . . . system characteristics . . . and human factors. A discussion of malfunction analysis also is included.

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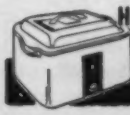

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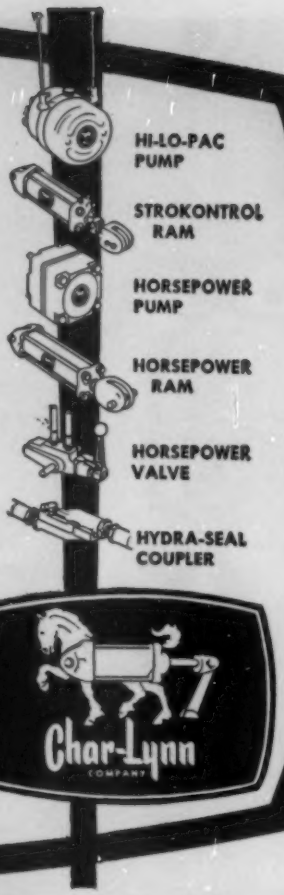

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MECHANICAL ENGINEER

Graduate Engineer with several years' experience on small hydro-mechanical devices. Capable of checking designs for production.

PLASTICS ENGINEER

Production and Development Engineer; experienced in formulation, evaluation and competitive analysis of all phases of dry blends and conventional extrusion compounds, plastisols, surface coatings, adhesives and sealers. State age, education, experience and salary requirements.

MECHANICAL ENGINEER

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Write Today Director of Personnel, The Electric Auto-Lite Company, Toledo 1, Ohio. You can make your letter as brief as you like. This may be your chance for the engineering future you have been looking for.

MECHANICAL ENGINEERS

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Salary Range $500 to $900

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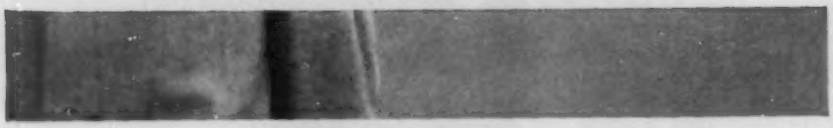

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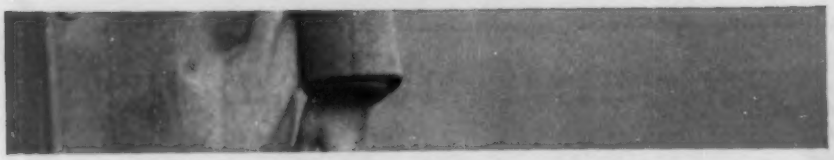

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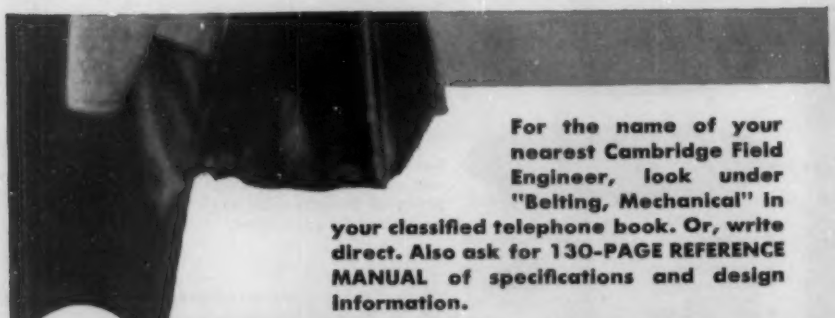

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105 Circuit Avenue, WEST SPRINGFIELD, MASS.

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Design engineers tell us they consider L·O·F Glass Fibers' insulation "the insulation with unique design possibilities."

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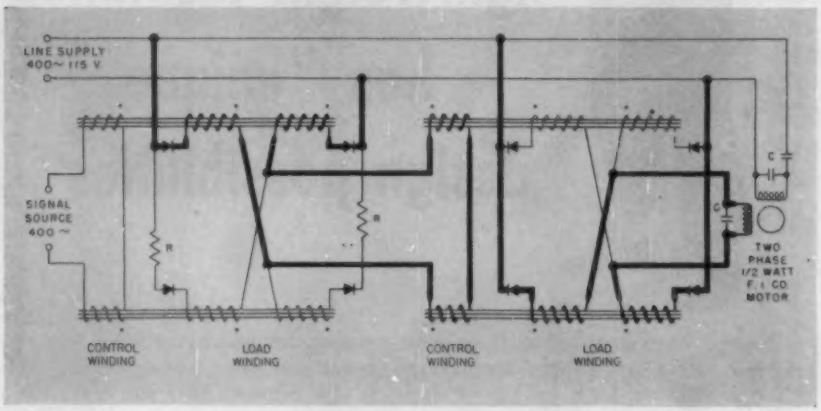

Ford Instrument Company has perfected and holds the basic patents on circuits which allow cascading magnetic amplifiers with stages operating on successive half-cycles of the a-c supply.

In the circuit shown here, amplification in each stage of the amplifier is accomplished by pre-setting the core fluxes with the control-winding signal during one half-cycle of the applied load-winding voltage. During the next half-cycle, when the load-winding conducts, the control winding contribution is negligible. In this mode of operation the control winding of each stage of the amplifier receives its signal during the reset or non-conducting half-cycle of that stage of amplification. The effect of this signal occurs during the next half-cycle, thus the time constant in the stage is at a minimum of ½ cycle.

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57

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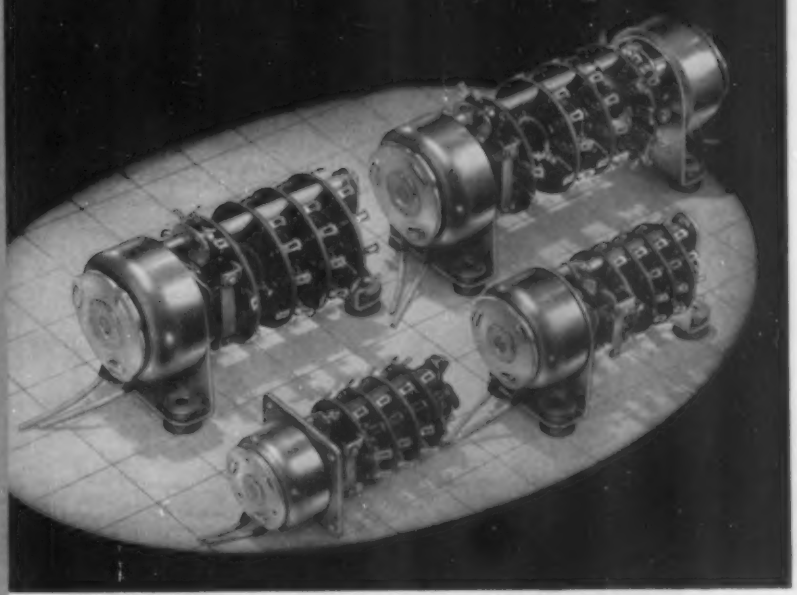

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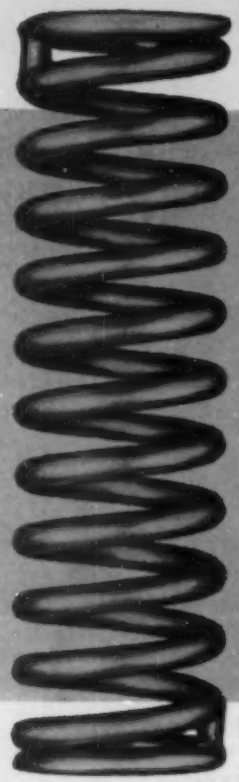

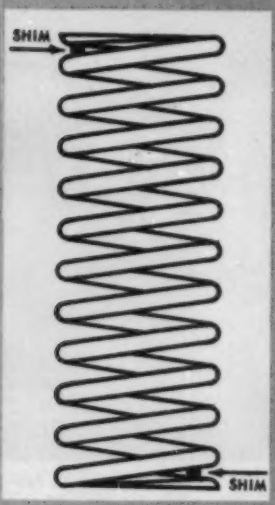

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Manufacturer of Precision Springs and Measuring Apparatus Since 1835

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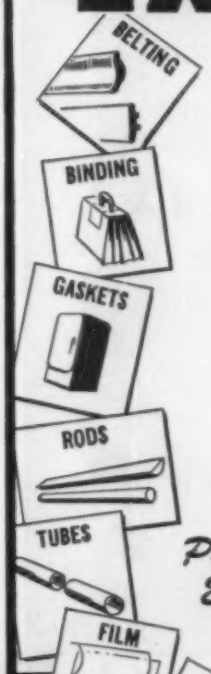

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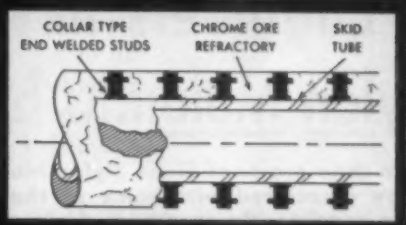

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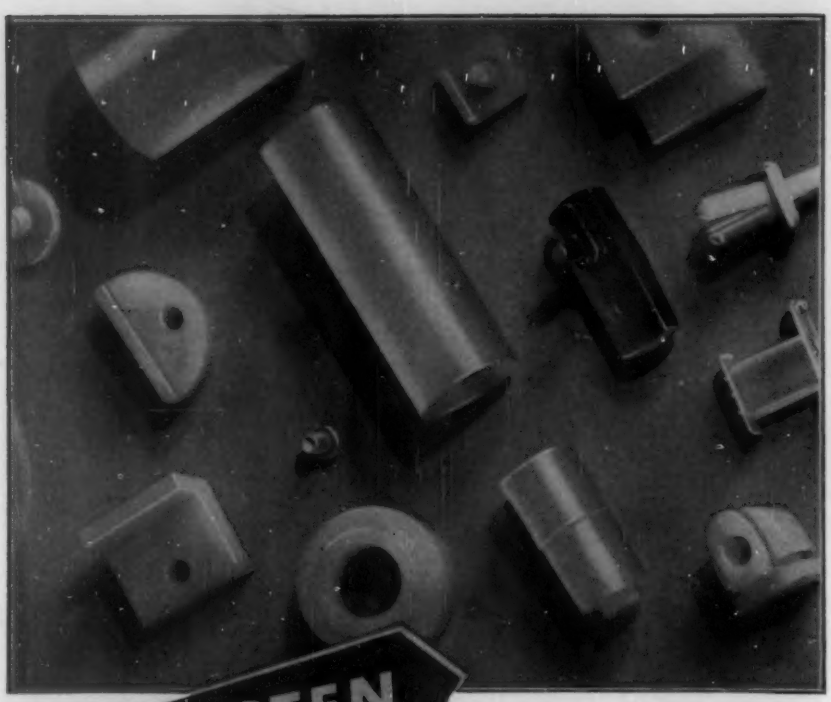

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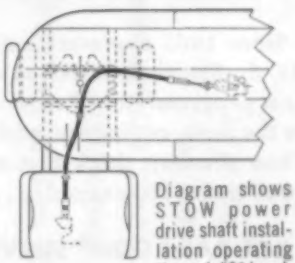
STOW flexible shafting
ON THE JOB

pumping GAS on a tractor-trailer



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3—Pneumatic Clutches Of 1 to 31 Hp
4—Position-Sensitive Transducers
5—Automatic Reset Timer
6—Self-Locking Bolts Have Inserts
7—Bearing and Flange Unit
8—Indexing Drives
9—Flange-Mounted Bearings
10—Worm Gear Reducer
11—Variable Speed Pulley
12—Double Reduction Speed Reducer
13—Fastener for Flush Mounting
14—Flexible Coupling
15—Steel Threads in Wood
16—Aircraft Panel Fastener
17—Self-Sealing Shake-Proof Screws
18—Flexible Conveyor Roll
19—Hydraulic Cushioning Spring
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33—Electronic Line Flow Switch
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37—Speed Sensitive Switch
38—Heat-Sensitive Relay
39—Timers For 10 sec to 30 hr
40—Rotary Reset Thermopilot Relay
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42—Motor Control Relay
43—Relay Powered by Rotary Solenoid
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45—Totalizers for High Output
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56—Machine Safety Guard
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59—Springdriven Stepping Switch
60—Sampling Switch With 5 cps Motor
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62—Grounding Receptacle
63—Heavy-Current Hermetic Terminal
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85—Vent and Breather Valve
86—Vacuum-Sealed Valve
87—Alloy Gate, Globe, Angle Valves
88—Gate Valve
89—Four-Way Solenoid Poppet Valve
90—Needle, Toggle and Check Valves
91—Three and Four-Way Valves
92—Four-Way Air Control Valves
93—Forged Steel Gate Valve
94—Hydraulic Control Valve
95—Will Hold In Either Position
96—Constant Speed Hydraulic Motor
97—Dry Solenoid Valve
98—All-Metal Motor Valve
99—Hydraulic Steering Booster
100—Dual Vane 2000 Psi Pump
101—Clamp-Type Air Cylinders
102—Cylinders for Air or Oil
103—Air, Hydraulic Booster Cylinder
104—Hydraulic Cylinders
105—High Pressure Rotating Swivel
106—Couplers and Connectors
107—Mount for Hydraulic Cylinders
108—Flow Volume Control
109—Porous Metal Made from Wire
110—Porous Silver Bearing
111—Protective Coating For Metals
112—Stainless Steel 400 Mesh Cloth
113—Porous Aluminum
114—Magnesium-Thorium Alloy Sheet
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120—Optical Hardness Testing Machine
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123—"Stackable" Power Supply
124—Four Six-Channel Oscillograph
125—Laboratory Power Supplies
126—Twin Transistor Power Supply
127—Portable Oscilloscope
128—Unitized Oscilloscope
129—Large-Screen Oscilloscopes
130—Portable Oscillograph Recorder
131—Recording Oscillograph
132—Vibration Pickup Probes
133—Whiteprinter
134—Low Resistance Bridge
135—Measures Machine Speeds
136—Temperature Indicators

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140—Die Castings
141—Spring Clutches
142—Steam Valves
143—Relays
144—Cold-Finished Steel Bars
145—Cooling Devices
146—Superchargers
147—Rotary Air Motors
148—Metal Hose
149—Aluminum Extrusions
150—A-c Motors
151—Four-Way Valve
152—Oscillographs
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154—Voltmeter Multipliers
155—Posture Chairs
156—Resistors
157—Locknuts and Fasteners
158—Aluminum Extrusions
159—Tooling Resins
160—Vulcanized Fiber
161—Self-Synchronous Motors
162—Elevated Tempertaure Mountings
163—Steam Traps
164—Stainless Steel Welding
165—Chemical Pumps
166—Plastic Structures and Pipe
167—Electronic Control Equipment
168—Glass Products

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175—Sealed Bearings
176—Twist Prong Capacitors
177—Brass Products
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189—Reducing Camera
190—Temperature Control Systems
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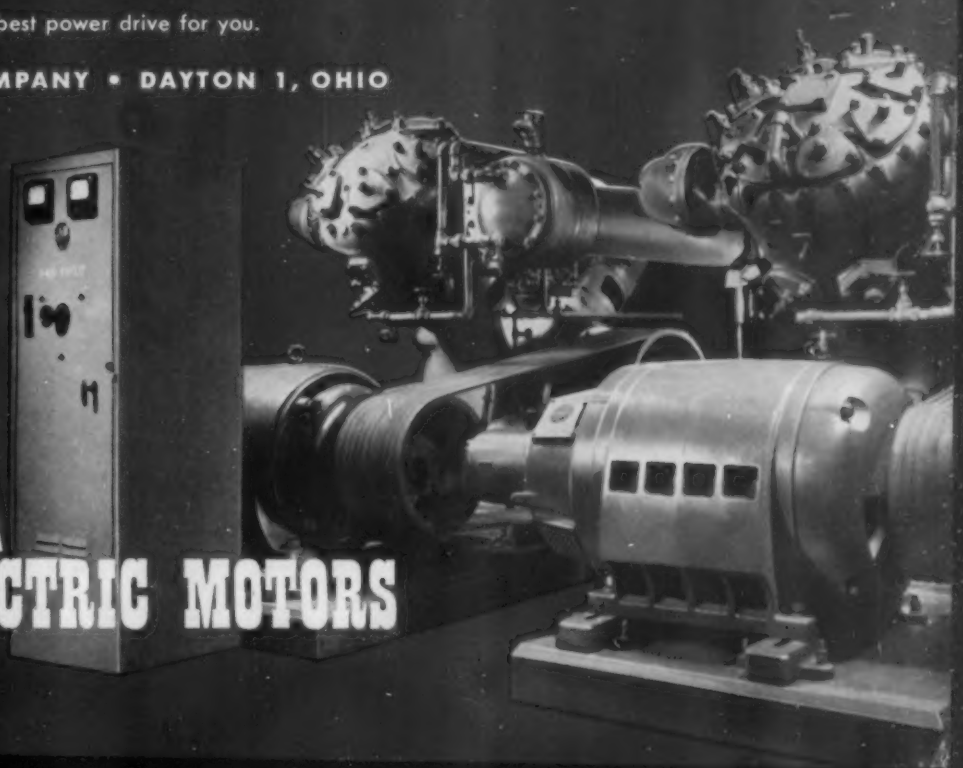

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